AD-A102 294   MITRE CORP BEDFORD MA   F/G 17/2.1
MICROCOMPUTER POLLING IMPROVEMENTS FOR AFSATCOM.(U)
JUN 81 J HANDWERKER   F19628-81-C-0001
UNCLASSIFIED MTR-8239   ESD-TR-81-118   NL

1 of 2
AD
A102294

ESD-TR-81-118

MTR-8239

MICROCOMPUTER POLLING IMPROVEMENTS FOR AFSATCOM

JACOB HANDWERKER

JUNE 1981

Prepared for

DEPUTY FOR COMMUNICATIONS AND INFORMATION SYSTEMS
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Hanscom Air Force Base, Massachusetts

Project No. 6340
Prepared by

THE MITRE CORPORATION
Bedford, Massachusetts

Contract No. F19628-81-C-0001

REVIEW AND APPROVAL

This technical report has been reviewed and is approved for publication.

(Signature)
Joseph Mardo/GS-13
Project Engineer

FOR THE COMMANDER

(Signature)
MAX I. MILLER, Jr., Colonel, USAF
System Program Director
Satellite Communications Terminal SPO
Deputy for Communications and
Information Systems

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER ESD-TR-81-118	2. GOVT ACCESSION NO. AD-A102 294	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MICROCOMPUTER POLLING IMPROVEMENTS FOR AFSATCOM		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER MTR-8239
7. AUTHOR(s) Jacob Handwerker		8. CONTRACT OR GRANT NUMBER(s) F19628-81-C-0001
9. PERFORMING ORGANIZATION NAME AND ADDRESS The MITRE Corporation P.O. Box 208 Bedford, MA 01730		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Project No. 6340
11. CONTROLLING OFFICE NAME AND ADDRESS Deputy for Communications and Information Systems Electronic Systems Division, AFSC Hanscom AFB, MA 01731		12. REPORT DATE June 1981
		13. NUMBER OF PAGES 122
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AFSATCOM MICROCOMPUTER
AFSATCOM POLLING
MICROCOMPUTER
MICROPROCESSOR
POLLING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents a cost effective approach for an on-line, remotable demonstration of AFSATCOM polling improvements made possible through currently available, general purpose microcomputer technology. Descriptions of present and enhanced AFSATCOM terminal capabilities, and a comprehensive overview of the resultant microprocessor-based hardware and software, and the support facility are presented. The conclusion is that message processor unit software-only changes or stand-alone microcomputer hardware additions to existing AFSATCOM terminals can significantly enhance (over)

DD FORM 1 JAN 73 1473

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Continued)

netting capabilities for the satellite-user community

ABSTRACT

This report documents a cost effective approach for an on-line, remotable demonstration of AFSATCOM polling improvements made possible through currently available, general purpose microcomputer technology. Descriptions of present and enhanced AFSATCOM terminal capabilities, and a comprehensive overview of the resultant microprocessor-based hardware and software, and the support facility, are presented. The conclusion is that message processor unit software-only changes or stand-alone microcomputer hardware additions to existing AFSATCOM terminals can significantly enhance netting capabilities for the satellite-user community.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to Robert K. Waite whose software and hardware expertise and general participation in the microcomputer project described herein were instrumental to its success. Also, recognition is given to Anthony J. Lauletta for his mechanical and electronic skills in assembly of the system, and to Fay S. Durk for providing needed support and understanding of MITRE's Time Sharing Option (TSO) system. Finally, acknowledgment is made to William T. Higgins for his unwavering managerial support which ensured the success of this project.

This report has been prepared by The MITRE Corporation under Project 6340. The contract is sponsored by the Electronic Systems Division, Air Force Systems Command, Hanscom Air Force Base, Massachusetts.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (concluded)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (concluded)

LIST OF TABLES

SECTION 1

INTRODUCTION

This report describes a breadboard microcomputer system based on an Intel SBC 80/20 Single Board Computer (SBC) which fulfills the project demonstration requirements for an improved polling capability for various satellite terminal users. The system underscores the flexibility and power of microprocessor-based hardware and software applications and provides extensive simulation capabilities related to terminal performance improvements for Air Force Satellite Communications (AFSATCOM) ultra high frequency (UHF) satellite communications in a real-time environment.

A preliminary study to investigate the attributes and growth potential of the AFSATCOM narrowband (NB) automatic Roll-Call Polling mode was undertaken by The MITRE Corporation for the Electronic Systems Division/Air Force Systems Command (ESD/AFSC). The purpose of this study was to lay the groundwork for eventual implementation of polling mode enhancements through software-only changes to the AFSATCOM message processor unit (MPU) subsystem as one means of improving overall netting capabilities. Subsequent polling-related studies involving advanced concepts have identified growth possibilities in the MPU subsystem which need software-only changes.

As a result of these studies, it was concluded that many of these new polling capabilities could be demonstrated easily and economically through use of currently available microcomputer techniques without the need to modify any existing AFSATCOM hardware or software. New functional capabilities could be added by a serially transparent microcomputer using existing interfaces presently employed by the AFSATCOM MPU subsystem. A polling improvements project was therefore undertaken which resulted in the development and testing of the microcomputer system detailed in this document.

To place the polling improvements in perspective, an overview of the AFSATCOM space and terminal segments is presented in section 2. Section 3 briefly describes the polling improvements project and its initial test results. Section 4 presents details of the polling improvements actually implemented by using a microcomputer add-on enhancement with an AFSATCOM terminal. Sections 5 and 6 provide details of the microcomputer hardware and software, respectively, for the demonstration system. Section 7 presents the overall conclusions and recommendations with regard to AFSATCOM polling enhancements and the follow-on objectives and planning for

subsequent demonstration testing. The AFSATCOM Roll-Call Polling mode is described in appendix A and a full source code listing is provided in appendix B.

SECTION 2

AFSATCOM SYSTEM OVERVIEW

The AFSATCOM System is designed to provide command, control, and communications capability on a worldwide basis to Single Integrated Operations Plan (SIOP) and other designated high priority users for emergency action message (EAM) dissemination, force direction, force reportback, and Commander-in-Chief (CINC) internetting. Communications are also provided for a limited number of non-SIOP normal force elements. The AFSATCOM System operates in the 225 to 400 MHz UHF spectrum and uses the 75 bits-per-second (b/s) teletype (TTY) service with frequency shift keying (FSK) modulation.

The AFSATCOM System, depicted in figure 2-1, consists of a space segment and a terminal segment. The space segment includes a communications capability designed into satellites such as the Navy Fleet Satellite Communications (FLTSATCOM) satellites as well as Air Force transponders carried "piggy-back" on other vehicles. The terminal segment is composed of various configurations operationally characterized as SIOP, normal force (non-SIOP), and command. SIOP and normal force terminals utilize only 5-kHz NB FSK channels, while command terminals also have access to an M-ary FSK 500-kHz bandwidth wideband spectrum. To ensure orderly management of day-to-day operation and control, each terminal user is part of an overall AFSATCOM System control structure.

2.1 SPACE SEGMENT

The AFSATCOM space segment consists of several types of transponder carried on different host satellites. AFSATCOM equipment is designed into each of the Navy FLTSATCOM satellites in geosynchronous equatorial orbit to provide overlapping earth coverage in all areas except the polar regions. Polar coverage is provided by Satellite Data System (SDS) satellites placed in highly inclined elliptical orbits.

Each satellite has 12 NB channels for specific user functions. The first seven NB channels are used to disseminate the EAM, force direction, and force reportback for SIOP/nuclear-capable forces. The next four NB channels are assigned to support essential operations of non-SIOP high priority Air Force users. The twelfth NB channel is used for system control and is designed to function as the orderwire (OW). Each of the FLTSATCOM satellites also has a

IA-59,071

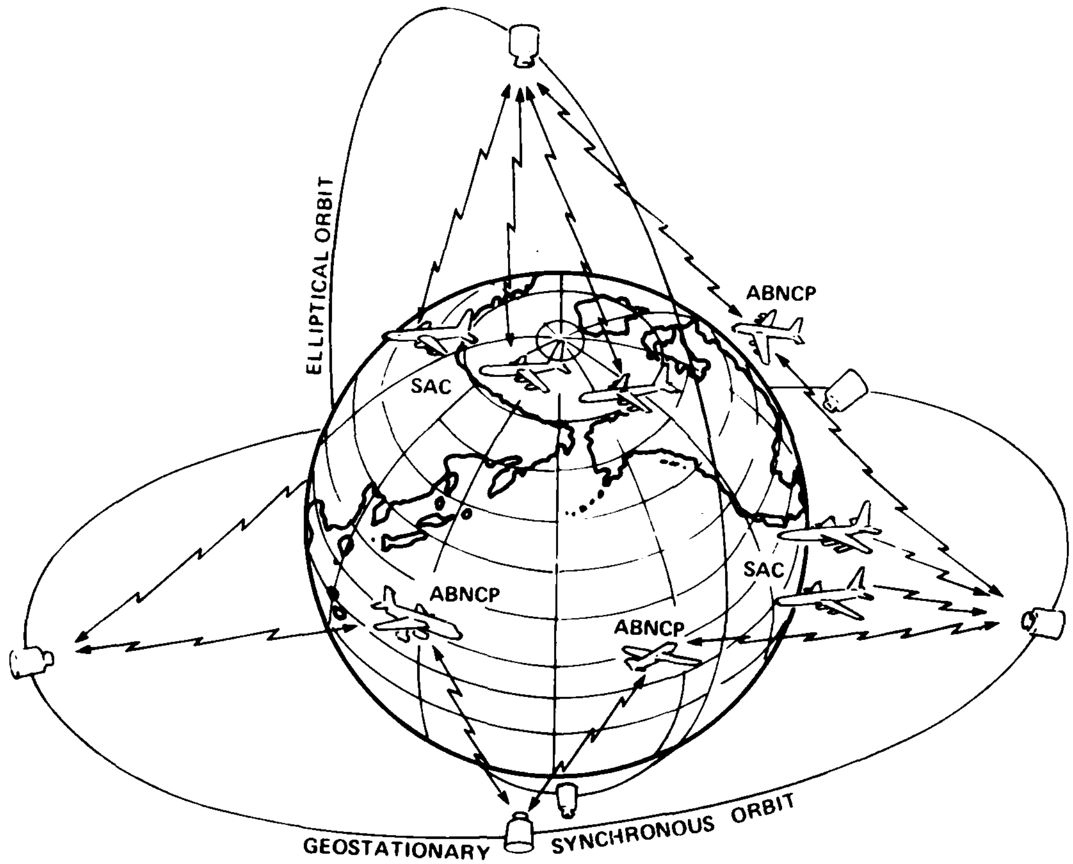


Figure 2-1 AFSATCOM System Concept

wideband (WB) channel. Accesses on the WB channel have been assigned to the National Command Authority (NCA), the CINCs, and members of the Worldwide Airborne Command Post (WWABNCP) fleet for the CINC Internet. SIOP and force terminals do not have access to the WB channel. Command post and net control terminal elements have the capability to command the various satellite modes using their OW or NB channel equipment.

2.2 TERMINAL SEGMENT

The AFSATCOM terminal segment consists of various equipment configurations to meet SIOP, normal force, and command operational requirements. The terminals are airborne or ground-based depending on the user application.

SIOP terminals provide 75 b/s half-duplex TTY operation via the 5-kHz NB satellite channels and can be operated in time division multiplex (TDM) modes under control of a command post. The input/output (I/O) devices are a keyboard, teleprinter, and appropriate control/monitor panels. Hard copy is available from terminals using the teleprinter. A SIOP synchronizer provides proper synchronization during TDM operation.

Normal force terminals (airborne and ground) provide 75 b/s half-duplex TTY operation via a 5-kHz, fixed frequency satellite channel. The absence of a SIOP synchronizer allows the normal force terminals to operate only in non-TDM modes.

Command post (CP) terminals can send, receive, and monitor messages; establish SIOP timing synchronization for TDM-1 (normal) and TDM-2 (stressed) modes; provide satellite UHF commands; initiate EAMs; and operate in a network control system using an OW channel. They can also monitor and record all reportback data to allow command transition. These terminals use full-duplex 75 b/s TTY operation on the 500-kHz WB channel, along with half-duplex and full-duplex 75 b/s TTY on the 5-kHz NB channels. Each CP terminal can operate as either a CP terminal or SIOP force terminal when in a slave mode. In the slave mode, SIOP timing synchronization is provided by another CP terminal. The AFSATCOM Type 12 CP terminal is described below since it was used for the polling improvement demonstration capability discussed later.

2.3 AFSATCOM TYPE 12 COMMAND POST TERMINAL

The AFSATCOM Type 12 (AN/TSC-88) CP terminal provides full-duplex record communications using FSK modulation at 75 b/s and is housed in an S-280 shelter that can be transported for rapid global deployment. The terminal consists of equipment installed in four electrical equipment cabinets and a two-position operator console, all within the shelter. Steerable and fixed antennas are set up outside the shelter when it is operational and are stowed inside during transport. Figure 2-2 is a functional block diagram of the Type 12 CP terminal.

Five AN/ARC-171 transceivers (R/Ts) and their associated controls, in conjunction with two half-duplex and one full-duplex narrowband modems, and two full-duplex wideband modems, provide five transmit (TX) and 12 receive (RX) communications channels. These channels are identified as follows:

- NB-1: a one transmit/one receive (1x1), half-duplex, NB (5-kHz) channel.
- NB-2: a one transmit/eight receive (1x8), full-duplex, NB (5-kHz) channel.
- OW: a one transmit/one receive (1x1), half-duplex, NB (5-kHz) channel.
- WB-1: a one transmit/one receive, full-duplex, WB (500-kHz) channel.
- WB-2: a one transmit/one receive, full-duplex, WB (500-kHz) channel.

Several narrowband operating modes are available in the AFSATCOM System. During normal operation, messages on NB channels one through seven are received by FLTSATCOM and SDS satellite packages on fixed uplink frequencies and retransmitted on fixed downlink frequencies. Methods of transmission in the normal mode include random and polled access. Random operation allows the terminal to enter the net on a random access basis using an open (not busy) select channel. Polled operation allows the Type 12 CP terminal to query each terminal in the net in sequence, with each terminal responding automatically with a precomposed message when it detects its own unique code sequence.

All of the NB channels, including the OW channel, can be used for automatic polling. In the polling mode, the Type 12 CP terminal sequentially addresses poll inquiry messages to terminals assigned

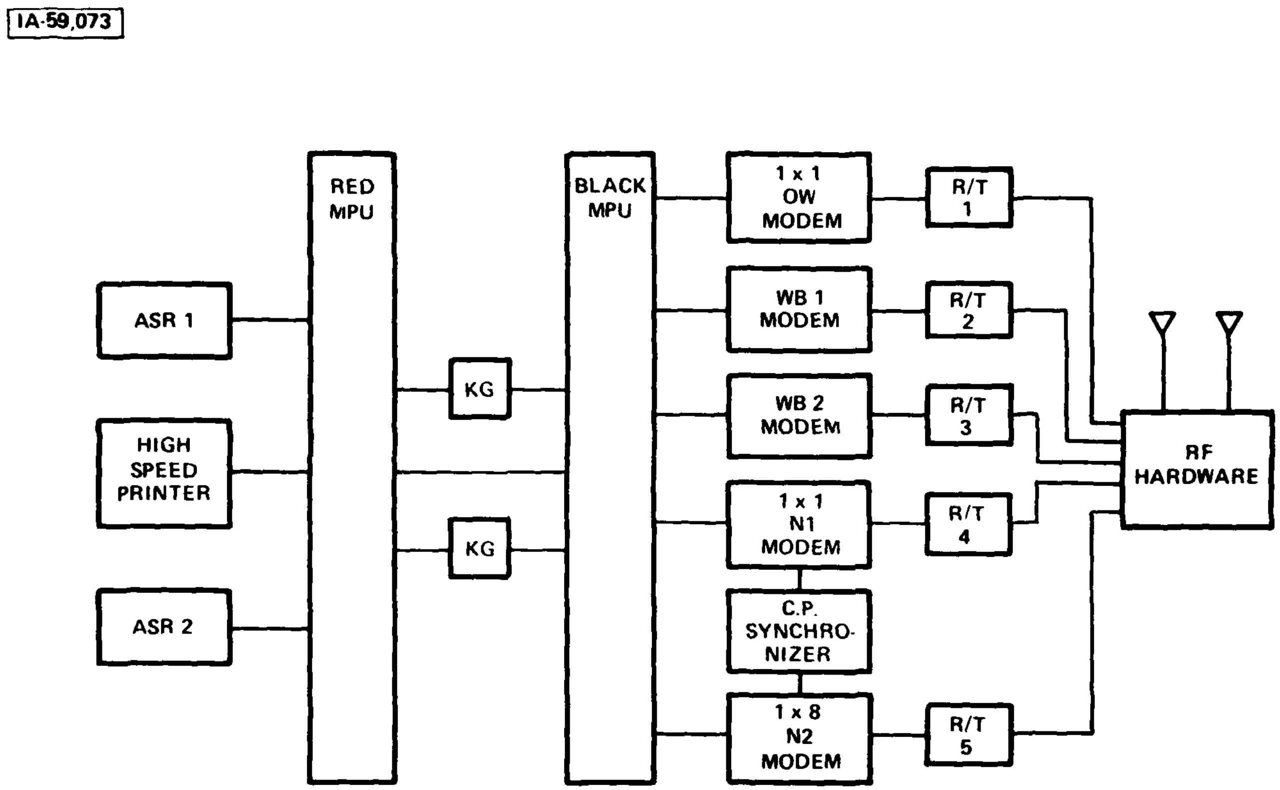


Figure 2-2 Type 12 Ground Command Post Functional Block Diagram

to various poll groups. Poll groups and polling operations are under the control of software programs in the terminal computer, the MPU. Four separate poll groups and up to 16 members apiece are allowed by the software. Each terminal to be polled will precompose a poll response message. When the unique address of that terminal is recognized in a poll message, the precomposed message of up to 30 seconds in length is automatically transmitted.

During periods of high density traffic, the Type 12 terminal can initiate synchronized operation for SIOP users by implementing a TDM mode. In this mode, the CP synchronizer periodically transmits a sync message which automatically establishes a time reference within each SIOP terminal in the net. In the TDM-1 mode, each SIOP terminal is constrained to transmit a precomposed message within its assigned time slot. Sixty consecutive time slots constitute a frame after which the sequence is repeated, with the CP synchronizer transmitting a new sync message in the last time slot of each frame.

During TDM-1, only the transmit time of each SIOP terminal is controlled by the CP synchronization message. During TDM-2, both the transmit time and transmit frequency of each SIOP terminal are synchronized by the CP synchronizer. In the TDM-2 mode, the satellite transponder is commanded into a stressed mode, which causes the first seven NB receive channels in the satellite to frequency hop on a pseudorandom basis. Also in the TDM-2 mode, each SIOP terminal is constrained to transmit in its assigned time slot and the transmit frequency changes with each time slot. The transmit frequency is determined by the code-of-the-day which is programmed into each synchronizer by the operator. Before the net can enter the TDM-2 mode, the satellite must be commanded into the stressed mode.

Three modes of operation are also provided on the WB M'ary FSK channels. These are: (1) random access precomposed message; (2) random access manual message composition; and (3) full-duplex relay, which is also available in NB random access mode.

During normal CP terminal operations, communications channels OW and WB-2 are assigned to operate with a fixed antenna. The WB-1, NB-1, and NB-2 channels are assigned to operate with a tracking antenna. Antenna switching is provided to allow the OW and WB-1 channels to operate with either antenna.

Additional details pertaining to the AFSATCOM Type 12 terminal can be found in another document.

2.4 CURRENT AFSATCOM POLLING CAPABILITIES

The present AFSATCOM polling capability is primarily structured for automatic operation in the non-TDM unencrypted mode over a single 5-kHz NB channel. Polling operations for AFSATCOM System control are conducted from MPU-equipped terminals by utilizing a polling algorithm contained in the MPU software. Communications supervisory (COMSUP) commands input by the terminal operator are used either to enter or delete poll addresses as well as to start polling operations. Up to 64 pollees may be entered into a poll net consisting of four groups having 16 members, maximum, per group. Addresses for each group member are related to others in the same group, with poll address recognition actually taking place within the AFSATCOM automatic send-receive (ASR) I/O hardware. During MPU automatic polling operations, a non-reportback of a polled address will cause a 30-second fixed time-out delay within the MPU before generation of the next poll message. Appendix A gives a more complete description of current AFSATCOM polling operation, including polling message formats, address structure, and poll-related COMSUP commands for the MPU.

2.5 POLLING LIMITATIONS

The following limitations of the AFSATCOM polling mode constrain its utility in an operational environment.

1. Small Network Size

   A maximum of only 64 pollees can be accommodated in the existing MPU polling software. Present AFSATCOM requirements forsee nets needing to accommodate between two and three times this number.

2. Inflexible Addressing Structure

   The group organization required in present auto polling dictates that all members of a poll group have the last two of their three address characters in common. Polling always commences with the lowest address of each group of 16 and proceeds in sequence toward the highest address before attempting to poll the next group. No provision is made for randomized poll addressees who are not group-related members.

3. No Prioritization/Interruption Features

No provision is made for real-time prioritization of pollees based on operational needs for early or more frequent reportback requirements. Also, no provision is made for momentary or short-term interruptions of polling operations to accommodate higher priority traffic without complete repolling of all users.

4. Inefficient Bookkeeping Scheme

Current polling operations dictate that all poll address additions or deletions be entered by COMSUP command. This can be a time consuming process, especially since no provision for a truly automated MPU poll table generation/display is available to the operator. Also, prior coordination of poll address assignments is essential but is unwieldly when attempted in real-time. Manual bookkeeping procedures are thus mandated to keep abreast of current poll net membership.

5. No Automated Handover Procedures

No provision is currently made for an automated handover procedure to an alternate net control station (NCS) for polling operations. All poll address additions/deletions must be accommodated by the alternate NCS on a manual basis.

6. No TDM Polling Mode

Automatic polling is currently restricted to the non-TDM mode. Although TDM poll response is possible from a polled I/O, the existing MPU polling software is not presently configured to cope with the structural differences between AFSATCOM non-TDM and TDM operation since automated TDM polling was not originally conceived as a basic AFSATCOM netting requirement.

7. Single Channel Polling Restriction

Polling inquiry messages sent by the MPU during polling operations are limited to a single channel. Simultaneous, independent polling on more than one channel is not currently possible in a terminal equipped with a single MPU.

8. Unencrypted Reportback Limitation

In general, the 30-second time-out constraint during automatic polling limits the length of reportback possible. In addition,

MPU-equipped terminals incur internal MPU delays such that their reportback is limited to 130 characters, maximum. This restricts the use of the Auto Polling mode to unencrypted operation with a fixed upper limit on the size of a reportback message; the upper limit depends on the type of terminal responding.

9. No-show Delay Penalty

The present fixed 30-second time-out for auto-polling also incurs a severe delay penalty when a no-show occurs. A no-show, or non-reportback, may occur for a variety of reasons such as failure to properly receive the polling inquiry message, failure to be in the I/O poll mode, etc. Figure 2-3 shows the polling delay performance of the present non-TDM roll-call polling mode as a function of the number of non-reportbacks (assuming a 40-character reportback when one does occur) for the maximum net size of 64 polled non-MPU terminals. The vertical axis indicates the time to completion for polling the entire net. As fewer net members report back, the time to completion for polling increases dramatically. This is counter to the concept of maintaining a predictable level of AFSATCOM network performance in situations supposedly under the control of a CP terminal.

10. Error Detection and Correction

No automated procedure currently exists for repolling a net member upon detection of a character error while in the polling mode. The existing AFSATCOM unencrypted message structure provides for odd-parity character transmission, but this capability has yet to be fully exploited.

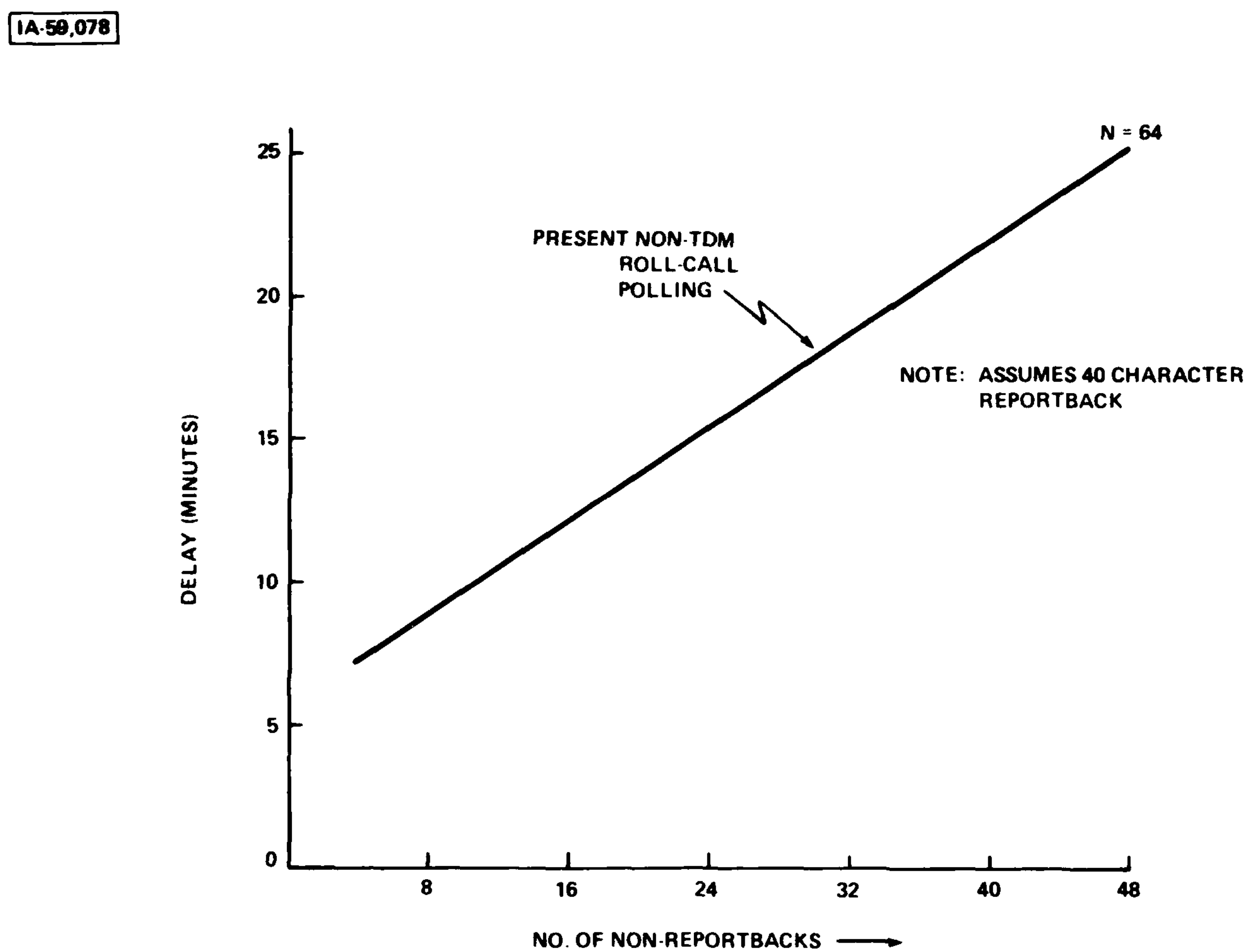


Figure 2-3 Polling Delay Performance

SECTION 3

AFSATCOM POLLING IMPROVEMENTS PROJECT

Providing enhanced polling capabilities by using AFSATCOM-compatible techniques to meet the ever increasing demands of the AFSATCOM System is a primary concern because the Air Force has an extensive hardware investment in terminal assets. Significant changes to present hardware or software must be evaluated with regard to both operational and logistical effects. Polling improvements should also provide flexibility for a wide range of applications yet to be defined and at the same time address the reportback needs of specific AFSATCOM users with known requirements.

3.1 PROJECT DESCRIPTION

A microcomputer-based approach for demonstrating various improved AFSATCOM polling capabilities, involving no hardware or software modifications to existing AFSATCOM equipment, was conceived by MITRE to be the most cost-effective means of validating many of the proposed concepts. The microcomputer provides real-time, on-line simulation of new polling capabilities while functionally emulating changes to MPU software. Making this microcomputer serially transparent to existing system operation with no need to modify AFSATCOM assets is an inexpensive way to validate new polling concepts. Operational MPU software does not need to be modified until after these concepts are validated and user coordination is achieved on a final implementation approach. Physically, the microcomputer interfaces between the MPU and either NB-1 or OW modem in the AFSATCOM Type 12 terminal. A project was initiated to translate these improved polling concepts into actual breadboard hardware and software suitable for demonstration purposes. For this purpose, the microcomputer development facility based around a Tektronix 8002A microprocessor laboratory at MITRE-Bedford was used.

Figure 3-1 describes the overall implementation approach for the project. Because of the small staff for this undertaking (two part-time MITRE technical staff), relatively close coordination between hardware and software design efforts was possible, with the result that the project was successfully completed in nine calendar months.

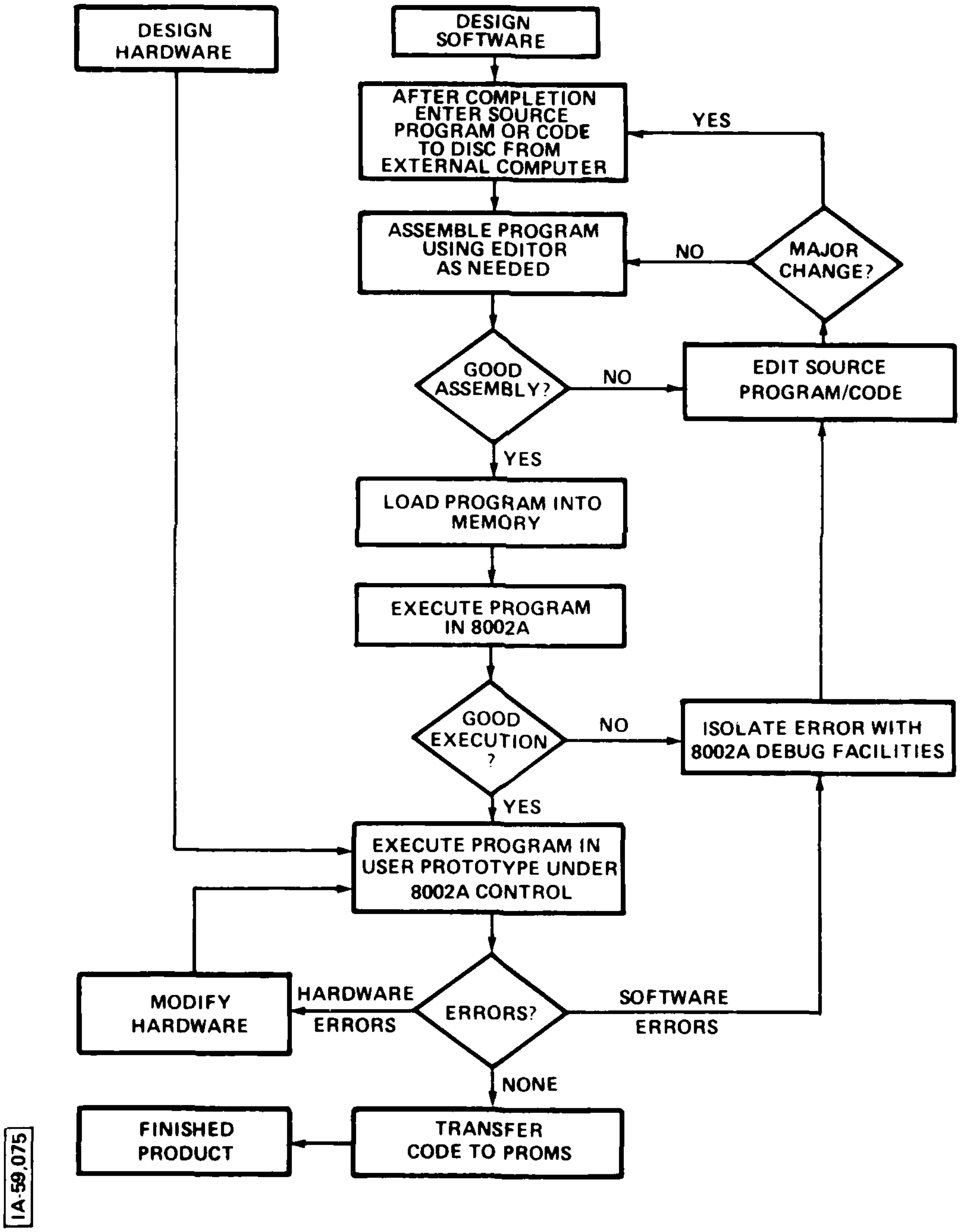


Figure 3-1 Polling Hardware/Software Design Cycle

3.2 LIMITED TEST RESULTS

Following completion of bench testing and terminal integration, the microcomputer system was made available for demonstration testing. Technical compatibility of the improved polling hardware/ software with the AFSATCOM Type 12 terminal was demonstrated during the initial tests. With the microcomputer installed in the terminal, both software and hardware bypasses provided AFSATCOM system transparency for normal AFSATCOM modes. After completion of various terminal performance tests, actual network testing was conducted using the FLTSATCOM satellites. All of the significant performance improvements for polling (described in detail in section 4) were also demonstrated successfully in conjunction with other cooperative AFSATCOM terminals operating through the satellite system. As a result, the microcomputer system is now considered available for network-wide tests on a much larger scale, with emphasis on operational testing to demonstrate improved netting capabilities to potential users.

SECTION 4

MICROCOMPUTER-BASED POLLING ENHANCEMENTS

Significant improvements to the present AFSATCOM polling mode operation have been achieved with the microcomputer-based addition to the AFSATCOM Type 12 CP terminal. These improvements have been demonstrated to participating terminal operators during actual on-line demonstrations.

4.1 MAJOR POLLING IMPROVEMENTS

The major polling improvements implemented in the AFSATCOM Type 12 CP terminal are described below. Table 4-1 compares existing AFSATCOM polling capabilities and the microcomputer-based improvements. These improvements are a real-time simulation of capabilities possible with software-only improvements to the AFSATCOM MPU.

4.1.1 Group/Non-Group Polling and Prioritization

The current AFSATCOM System can poll up to four groups of related net members where each group is defined as a set of 16 addresses and each address in the group has the same last two hexadecimal address characters. This group structure is retained in the improved polling software. In addition, a new set of net members is permitted which may contain up to 80 random addressees (equivalent to five 16-member groups) independent of any related group address structure. This provides flexibility to organize and poll up to a maximum of 144 group and non-group net members per channel.

During polling net organization with the microcomputer software, the non-group members are accorded a higher priority level with respect to group-related members. Four priority levels of polling net organization have been chosen for demonstration purposes: (1) priority check-ins, (2) routine check-ins, (3) no-traffic check-ins, and (4) group check-ins.

During polling operations, the non-group related check-ins of priority levels 1, 2, and 3 are polled before the group-related check-ins of level 4. The NCS terminal operator can enter any of these check-ins into the polling net by COMSUP command. A remote-entry automatic check-in for levels 1, 2, and 3 is also possible.

Table 4-1

Improved Polling Performance Comparison

AFSATCOM Functional Capability	Non-TDM Polling Mode		TDM Polling Mode	
	Present	With Microcomputer	Present	With Microcomputer
Auto Polling	Yes	Yes	No	Yes
Encryption	No	Yes	N/A	No
Limited EDAC	No	Yes*	N/A	No
Non-Group Polling/Prioritization	No	Yes	N/A	Yes
Auto Check-in	No	Yes	N/A	Yes
Automatic Slot Assignment	N/A	N/A	N/A	Yes
Variable Time-Out	No	Yes	N/A	N/A
Table Printout/Transfer (With Selective Routing)	No	Yes	N/A	Yes
Poll Interrupt/Resume	No	Yes	N/A	Yes
Number of Users	64**	144***	N/A	48/Frame

*Poll Messages Only
**Four Groups of 16
***Four Groups of 16 Plus 80 Non-Group Users

In addition to normal termination of polling, an automatic repoll capability has been provided to allow continuous monitoring of reportback status activity. Also, an interrupt-and-resume feature provides a standby mode for polling operations to accommodate higher priority communications without the need to re-initiate a repoll of net members who have already reported back.

4.1.2 Remote Entry Automatic Check-in

The microcomputer software provides an automatic remote self check-in before the start of actual polling operations. This allows potential users to become polling network members without manual intervention by the NCS terminal operator. A non-group polling list can be rapidly structured yet the work-load imposed on the operator by the large number of possible random addressees is minimized. This enhancement also allows check-in table entry while current polling operations are in progress.

The NCS terminal operator retains positive control of all check-ins, including remote check-ins with the following software features:

1. The remote check-in mode can be enabled or disabled separately by COMSUP command.

2. Check-ins can be verified using COMSUP commands to obtain hardcopy poll table printouts of listed poll check-ins and poll net members. (This includes both group and non-group check-ins.) Check-in addition/deletion can be accommodated by COMSUP command as needed.

3. Automatic slot assignment and reportback prioritization (order of reportback) of poll net members is done in the polling software before the start of actual polling operations; reassignment of slots is also possible with a COMSUP command.

4. An ALL CALL message initiated via COMSUP command by the NCS terminal operator informs all listed polling net members of their TDM slot assignments (to be dialed manually into their respective AFSATCOM synchronizers). Dial-up of respective slot assignments avoids subsequent contention problems during TDM polling operations should that mode become active.

4.1.3 TDM Auto Polling

This enhancement provides TDM auto polling in addition to the polling capabilities available in the non-TDM mode. Thus, AFSATCOM TDM-1 and TDM-2 system modes are made compatible with the new terminal polling capabilities. This implementation requires the AFSATCOM synchronizer in the CP terminal to act as a master (i.e., a net control element) during TDM polling operations.

To carry out auto polling in the TDM modes, the software utilizes a tabular listing containing the addresses of all terminals in the poll network and their respective assigned reportback time slots. The TDM mode provides 60 slots per frame. During actual polling operation in the TDM mode, eight contiguous slots containing up to six poll messages per slot at the beginning of each AFSATCOM frame are dedicated to sending polling messages from the CP terminal to the pollees. Three unassigned slots immediately following these eight may be used for break-in by unassigned or emergency users. The 48 slots following can then be used for terminal reportbacks. The final slot in the frame, however, is normally reserved for synchronization messages. Because each AFSATCOM terminal is assigned its own unique address, several pollees can be assigned to the same reportback slot. The microcomputer software presently provides for polling a maximum of 144 users in three successive frames (with 48 reportbacks per frame). This, however, is not an ultimate AFSATCOM System limitation. Up to three addressees may be assigned to the same slot under this polling scheme, but this number could be increased to accommodate additional users as necessary, if more frames are used.

The AFSATCOM TDM response of force terminals (or CP terminals in the slave mode) limits polling responses by a polled terminal to 40 message characters during a frame. Also, TDM polling does not have an encryption capability as presently implemented. However, various priority traffic indicators in the poll response message cause a printout alert message at the NCS terminal for subsequent operator action. These are described in more detail below.

4.1.4 Automatic Slot Assignment

In conjunction with TDM polling, the microcomputer software provides automatic slot assignment of listed poll net members for subsequent TDM reportback. Before actual start of polling, members of the network are informed of their slot assignments by means of an ALL CALL message generated by the software. This message also indicates which users have been accepted into the poll listing along with their priority order of reportback. The ALL CALL message, like

the slot assignment made during the course of compiling the poll table, is generated automatically by operator-initiated COMSUP command.

4.1.5 Encrypted Non-TDM Polling

The present AFSATCOM polling time-out limitation of 30 seconds precludes the use of long encrypted reportback sequences. The microcomputer system software, however, permits encrypted polling responses in the non-TDM mode of operation. The software is configured to recognize KG-35 encryption device message indicator (MI) sequences at the beginning of a message and automatically disables odd-parity checking in the AFSATCOM NB modem upon recognition of a valid MI header. While message traffic is being received during polling, no message time-out occurs in order to accommodate encrypted sequences of long lengths. Once received, the AFSATCOM MPU routes the incoming encrypted reportback to a KG-35 device for eventual decryption.

4.1.6 Error Detection and Correction (EDAC)

The present AFSATCOM polling capability does not provide for any EDAC during either polled or non-polled operations. The microcomputer software does provide limited EDAC during polling through satellite downlink monitoring of poll messages. Polling message retransmission then takes place upon detection of error. This technique, however, requires full-duplex operation (simultaneous transmit and receive) whereas the demonstration hardware is interfaced with either the AFSATCOM OW or the 1x1 NB modem, both of which are configured as half-duplex equipment.

With a full-duplex channel, after transmission of a polling message during non-TDM mode, the microcomputer compares the message sent with the one received on the satellite downlink and causes a retransmission of the same message upon detection of any mismatch. A maximum of three automatic poll message retransmissions is possible with the present microcomputer software. No EDAC is presently provided in the TDM polling mode nor is EDAC provided on reportback responses, although no inherent limitation precludes such additional capability.

4.1.7 Variable Non-Reportback Time-out

A variable non-reportback time-out feature using a COMSUP command with the microcomputer software provides the terminal NCS operator with an added dimension for control. By controlling the time-out delay from the possible non-reportback of polled terminals, the operator can minimize the time-to-completion of polling the overall network. The operator enters the COMSUP command with the desired time-out duration expressed in seconds. Note that the present AFSATCOM non-reportback poll time-out is a non-changeable 30 seconds, whereas the microcomputer software allows for a 1 to 99 second range. Choice of the optimum delay depends on actual satellite and AFSATCOM I/O device delays and the polling strategy to be employed. The ability to vary the time-out delay can have profound effects on the overall polling completion time.

4.2 NEW COMMANDS AND MESSAGES FOR POLLING

The following new polling commands and message formats are possible with the microcomputer software.

4.2.1 COMSUP Commands

Table 4-2 summarizes the new COMSUP commands available to the NCS terminal operator when using the microcomputer system polling enhancements. Note that all the commands listed contain the ZNR character field in the first three character positions in order to identify this properly as an unencrypted message in an AFSATCOM preproduction Type 12 terminal. (AFSATCOM production-type terminals would require a "UUU" sequence.) The fourth character position is an exclamation point ("!") which signifies a COMSUP message to the microcomputer's improved polling software. The fifth character position of a COMSUP message is always a mode character. Characters six through nine are microcomputer address characters. (The microcomputer address is also changeable via a COMSUP command.) COMSUP commands intended for the microcomputer, and any other unencrypted messages, are input to the AFSATCOM terminal and intercepted by the polling software. These COMSUP commands are never transmitted to the AFSATCOM modem.

The seven message categories defining the new COMSUP commands are shown in table 4-2. These functional categories satisfy the increased control and data entry requirements for the various polling mode enhancements.

Table 4-2

COMSUP Commands For Polling Enhancements

Command Type	Function(s)	Command Message Format
Check-in Table Entry	Enable External Check-ins	ZNR!SABC1
	Disable External Check-ins	ZNR!SABCØ
	Single Priority Check-in	ZNR!CABCAAA1
	Single Routine Check-in	ZNR!DABCBBB1
	Single No-Traffic Check-in	ZNR!EABCCCCØ
	Group Check-in	ZNR!BABCDD1
	Priority Table Load	ZNR!1ABC ADR1 ADR2
	Routine Table Load	ZNR!2ABC ADR3 ADR4
	No Traffic Table Load	ZNR!3ABC ADR5 ADR6
Check-in Table Deletion	Priority Table Re-initialize	ZNR!FABC
	Routine Table Re-initialize	ZNR!GABC
	No-Traffic Table Re-initialize	ZNR!HABC
	Group Table Re-initialize	ZNR!AABC
	Single Priority Deletion	ZNR!NABCPØ1
	Single Routine Deletion	ZNR!NABCRØ1
	Single No-Traffic Deletion	ZNR!NABCNØ1
	Single Group Deletion	ZNR!NABCGØ1

Table 4-2 (Continued)

COMSUP Commands For Polling Enhancements

Command Type	Function(s)	Command Message Format
Check-in/Poll Table Printout	Priority Table Printout	ZNR!UABCPXYZ
	Routine Table Printout	ZNR!UABCRXYZ
	No-Traffic Table Printout	ZNR!UABCQXYZ
	Group Table Printout	ZNR!UABCOXYZ
	Build/Printout of Poll Table	ZNR!MABC
	Poll Table Printout (Local)	ZNR!UABCZXYZL
	Poll Table Printout (Local and Remote All Call)	ZNR!UABCZXYZR
External Table Transfer	Priority Check-in Table Transfer	ZNR!TABCXXYZ
	Routine Check-in Table Transfer	ZNR!TABCYXYZ
	No-Traffic Check-in Table Transfer	ZNR!TABCZXYZ
	Poll Table Transfer	ZNR!TABCTXYZ

Table 4-2 (Continued)

COMSUP Commands For Polling Enhancements

Command Type	Function(s)	Command Message Format
Poll Mode Control	Single Poll Enable	ZNR!JABC1S
	Single Poll Disable	ZNR!JABCØS
	Multiple Poll Enable	ZNR!JABC1M
	Multiple Poll Disable	ZNR!JABCØM
	Non-TDM Poll Interrupt	ZNR!LABC1Ø
	TDM Poll Interrupt	ZNR!LABCØ1
	TDM and Non-TDM Poll Interrupt	ZNR!LABC11
	Disable All Poll Interrupts	ZNR!LABCØØ
	EDAC Mode Enable	ZNR!PABC1
	EDAC Mode Disable	ZNR!PABCØ
	Poll Message Time Delay	ZNR!KABC1Ø
	Reportback/Poll Message Slot Reassignment	ZNR!OABC10182634425004

Table 4-2 (Continued)

COMSUP Commands For Polling Enhancements

Command Type	Function(s)	Command Message Format
Miscellaneous	Disable COMSUP Msg. Printout	ZNR!4ABCØ
	Enable COMSUP Msg. Printout	ZNR!4ABC1
	Disregard All Non-COMSUP Msgs.	ZNR!VABC2
	Disregard Non-COMSUP Msgs. when Polling	ZNR!VABC1
	Enable Recognition of All Types of Msgs.	ZNR!VABCØ
	RS-232 I/O Enable	ZNR!QABC1
	RS-232 I/O Disable	ZNR!QABCØ
	Microcomputer Address Change	ZNR!IABCCAB
	Program Re-initialize	ZNR!RABC
	Loop-Around Message	ZNR* $\underbrace{.............}_{\text{Transmitted Message}}$

4.2.2 Error Messages

Table 4-3 summarizes the new error messages available to the terminal operator with the microcomputer software. These messages assist in either flagging anomalous COMSUP command inputs to the microcomputer or indicating to the operator when pre-determined limits have been reached for polling check-in messages.

4.2.3 External Message Formats

Table 4-4 summarizes the types of externally generated messages from the AFSATCOM modem which are used for polling operations with the microcomputer software. These messages are divided into three basic categories:

1. Single Check-in

2. Check-in Table Transfer

3. Reportback

The single check-in message is normally sent by a terminal desiring to become a member of a poll network. It is accepted by the microcomputer software after the check-in mode has been enabled by the NCS terminal operator.

Check-in table transfer message formats allow entry of entire sets of check-ins involving multiple addressees into appropriately prioritized check-in tables.

Reportback message formats are normally sent by a terminal responding to a poll inquiry message. When the microcomputer software recognizes these reportback formats during polling operation, appropriate prioritization header messages are appended to the incoming message before printout on the terminal I/O device.

Table 4-3

Error Message Formats

Message Name	Function	Message Text
ADRERRORHDR	Informs of incorrect address characters	Incorrect ADR Characters
ERRORHDR	Informs of incorrect mode character	Incorrect Mode Character
TFRERRORHDR	Informs of attempted check-in table transfer with no check-ins listed	Table Transfer Error: No Check-ins
OVERFLOWHDR	Informs of Check-in limit being reached	Check-ins at the Limit

Table 4-4

External Message Formats

Message Type	Function	Format
Single Check-in	Priority Check-in	$\overline{\text{SOH}}$ C ABC ADR1 Text
	Routine Check-in	$\overline{\text{SOH}}$ D ABC ADR2 Text
	No-Traffic Check-in	$\overline{\text{SOH}}$ E ABC ADR3 Text
Check-in Table Transfer	Priority Check-in Table Transfer	$\overline{\text{SOH}}$ X ABC ADR1ADR2....
	Routine Check-in Table Transfer	$\overline{\text{SOH}}$ Y ABC ADR3ADR4....
	No-Traffic Check-in Table Transfer	$\overline{\text{SOH}}$ Z ABC ADR5ADR6....
Reportback Message	Priority Report back	$\overline{\text{SOH}}$ P ABC Text
	Routine Report back	$\overline{\text{SOH}}$ R ABC Text
	No-Traffic Report back	$\overline{\text{SOH}}$ N ABC Text

SECTION 5

MICROCOMPUTER HARDWARE

The microcomputer developed for demonstrating AFSATCOM polling improvements is shown in the functional block diagram in figure 5-1. It consists of an Intel SBC 80/20 Single Board Computer, a National Semiconductor Model BLC 416 16K-byte programmable read-only memory (PROM) board, an Intel Model 450 16K-byte random access memory (RAM) board, a power supply subsystem, and interface/display logic circuitry. The SBC 80/20, RAM, and eraseable PROM (EPROM) boards are housed in the Intel SBC 604 Modular Cardcage/Backplane which provides interconnection for up to four plug-in boards. The SBC 604 also allows interconnection of two or more cardcage backplane assemblies for expansion, in addition to power supply connectors and signal line termination circuits. A small table-top 19-inch modular rack mounting, shown in figure 5-2, contains the cardcage, along with the power supply subsystem, slot selection and display circuits, bypass switches, test points, and cable terminations for circuit connections to the AFSATCOM System.

5.1 INTEL SBC 80/20 SINGLE BOARD COMPUTER

The Intel SBC 80/20 Single Board Computer is the heart of the microcomputer implementation for polling improvements. It is one of Intel's line of computer products and takes full advantage of large scale integration (LSI) technology to provide a self-contained computer capability on a single 6.75 x 12.00 inch printed circuit board. On-board capability provides a central processing unit (CPU), system clock, read/write memory, nonvolatile read-only memory (ROM), I/O ports and drivers, a serial RS-232 communications interface, priority interrupt logic, and two programmable timers. In addition, on-board multibus control logic and bus expansion drivers allow interfaces to multibus-compatible boards including expansion memory, digital and analog I/O expansion boards, peripheral controller, and other single board computers. A complete functional description of the SBC 80/20 is found in reference 1. Details of the SBC 80/20 are found in reference 2. Table 5-1 lists integrated circuit (IC) locations for polling program storage on the SBC 80/20.

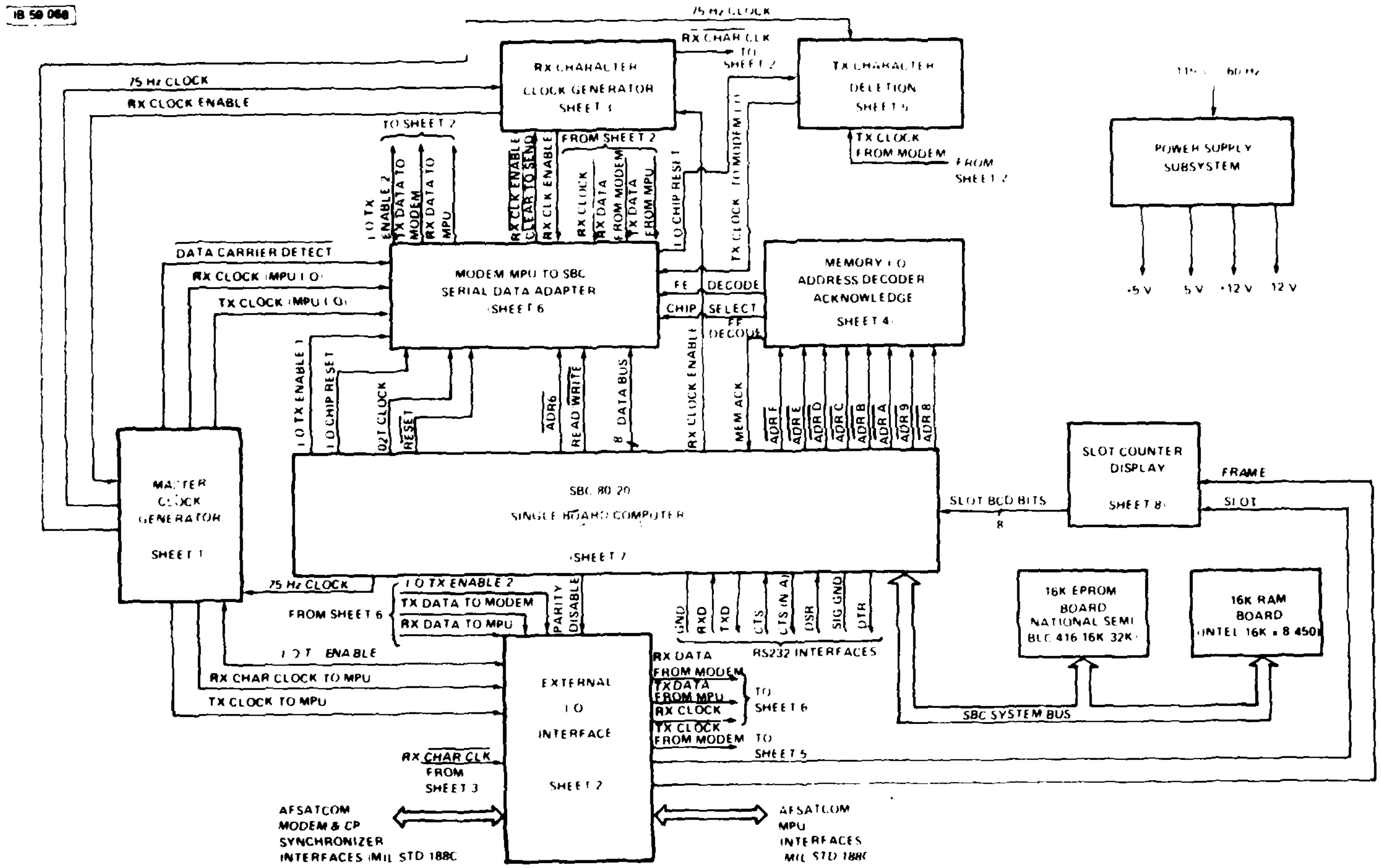


Figure 5-1 Microcomputer Functional Block Diagram

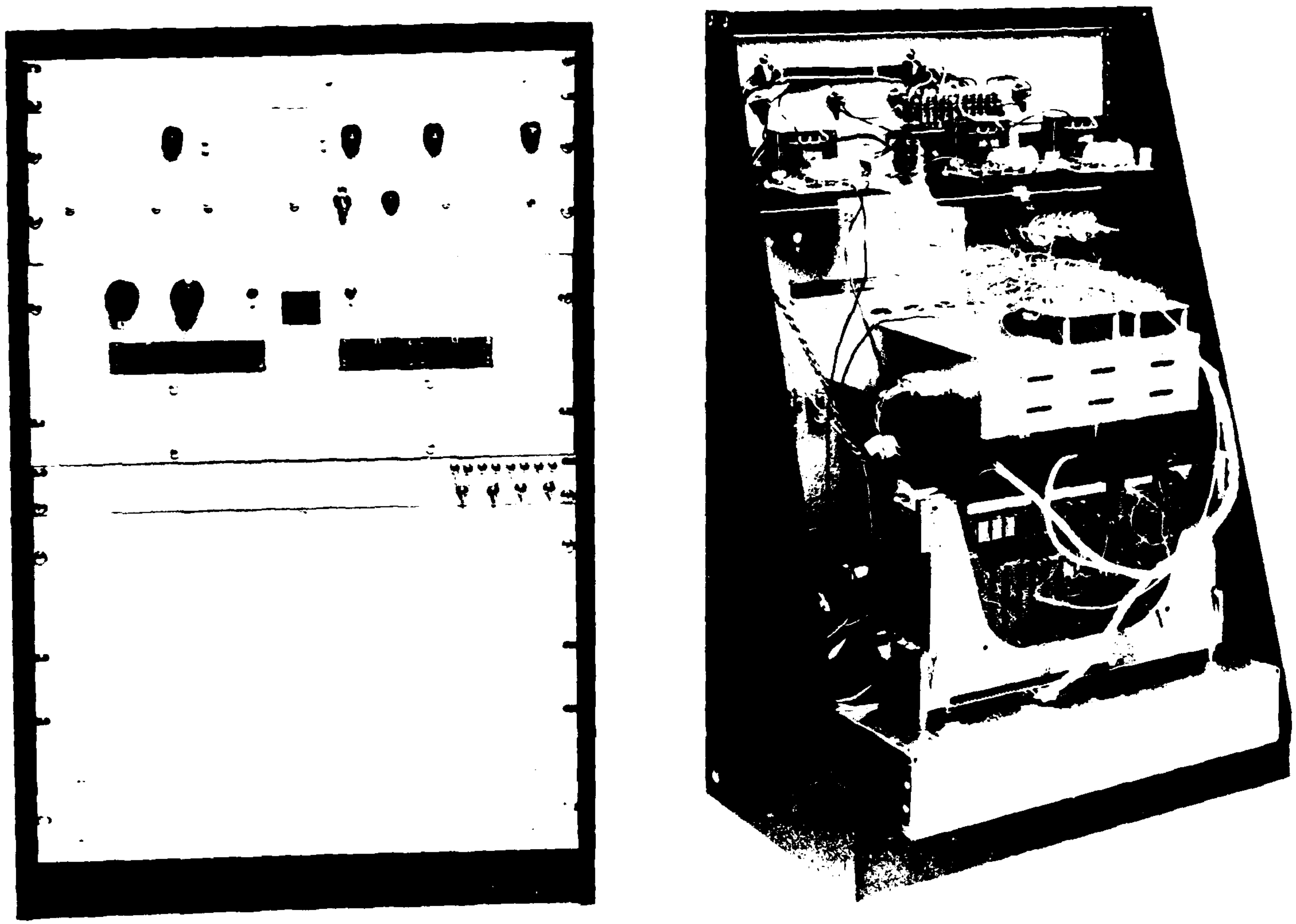


Figure 5-2 Microcomputer System Assembly

Table 5-1

EPROM (2708) Location Summary

Prom #	IC	Board	Start ADR (Hex)	Finish ADR (Hex)
1	A79	SBC 80/20	0000	03FF
2	A64	SBC 80/20	0400	07FF
3	A51	SBC 80/20	0800	0BFF
4	A37	SBC 80/20	0C00	0FFF
5	U33	BLC 416	1000	13FF
6	U21	BLC 416	1400	17FF
7	U9	BLC 416	1800	1BFF
8	U3	BLC 416	1C00	1FFF
9	U34	BLC 416	2000	23FF
10	U22	BLC 416	2400	27FF
11	U10	BLC 416	2800	2BFF
12	U4	BLC 416	2C00	2FFF
13	U35	BLC 416	3000	33FF
14	U23	BLC 416	3400	37FF
15	U11	BLC 416	3800	3BFF
16	U5	BLC 416	3C00	3FFF

5.2 NATIONAL SEMICONDUCTOR BLC 416 16K PROM BOARD

The National Semiconductor BLC 416 16K PROM expansion board provides sockets for up to 16K bytes of 2708 EPROMs (32K bytes for 2716 EPROMs). For the polling program, however, only 12 of the 16 2708 EPROMs required for program storage actually reside on this board; the four remaining 2708 EPROMs reside on the SBC 80/20. Table 5-1 summarizes the physical locations of the EPROM program storage for execution of the polling software. Switches to either enable or disable various memory blocks are provided on this board along with jumper-switch selectable addresses for each 4K block (8K when used with the 2716 EPROMs). This allows independent selection of base addresses of individual memory blocks on 4K byte boundaries. Along with on-board programming, the BLC 416 provides multibus-compatible address, data, and command signals. Table 5-1 lists the IC locations for polling program storage on the BLC 416 PROM board.

5.3 INTEL 450 16K RAM BOARD

The Intel 450 16K RAM is a multibus-compatible board which contains 16K bytes of read/write memory and uses 2107C dynamic memory components with on-board refresh circuitry for all the dynamic memory elements. Read/write buffering, which also resides on-board, buffers all data written into or read from the memory array and includes a jumper-selectable starting address for 16K contiguous addresses at 16K boundaries. For the polling application, the lowest RAM address is set at 4000H and the highest RAM address is 7FFFH.

5.4 I/O AND DISPLAY CIRCUITS

Figure 5-3 shows the additional cabling needed in the Type 12 CP terminal for interconnecting the I/O and display boards of the microcomputer system with the AFSATCOM System. No changes to existing AFSATCOM interfaces were made; only cabling and connector additions were employed. Each of the I/O and display circuits is detailed below.

5.4.1 Master Clock Generator

Figure 5-4 shows the Master Clock Generator circuit. This circuit provides various gated 75 Hz clocks and associated signals for both the transmit and receive functions utilizing a 75 Hz reference input from one of two timer circuits on the SBC 80/20.

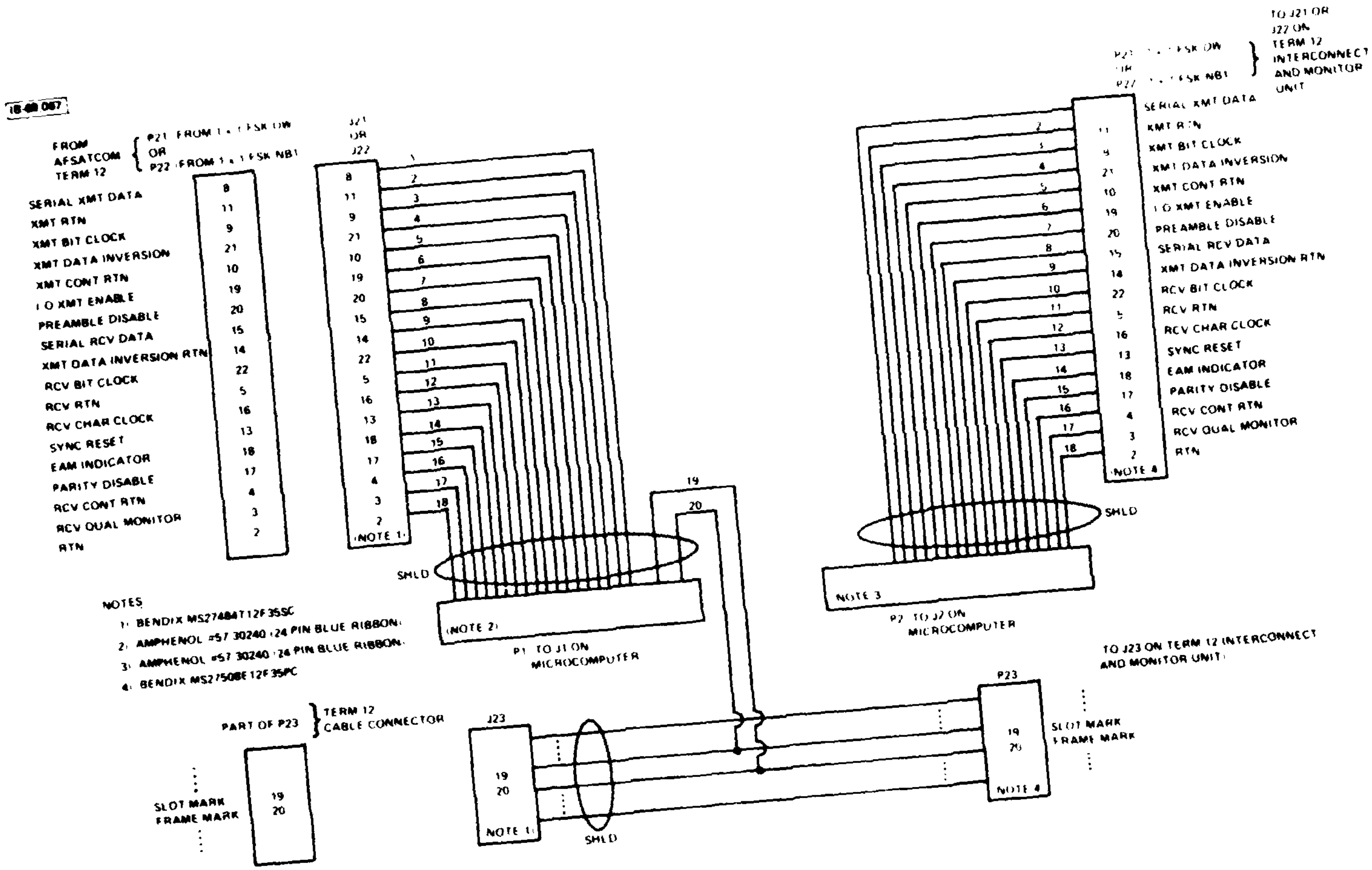


Figure 5-3 AFSATCOM T12-to-Microcomputer System Interface Diagram

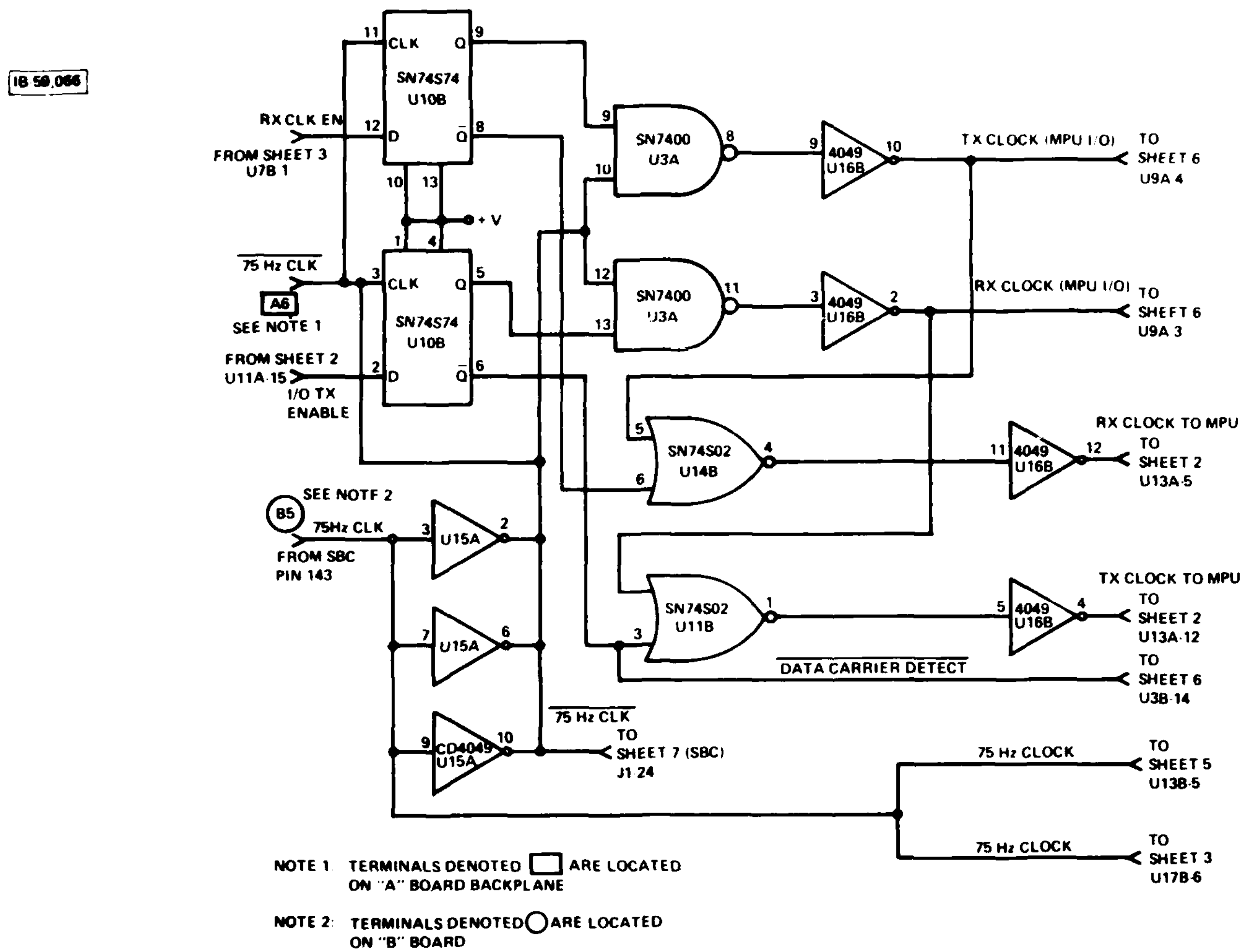


Figure 5-4 Master Clock Generator (Sheet 1)

5.4.2 External I/O Interface

Figure 5-5 shows the external I/O interface circuits. This circuitry provides the level conversion necessary to connect the MIL-STD-188C interfaces found in the AFSATCOM Type 12 terminal with the complementary metal-oxide semiconductor (CMOS) and transistor-transistor logic (TTL)-compatible circuits of the microcomputer system.

5.4.3 RX Character Clock Generator

Figure 5-6 shows the RX character clock generator circuit. This circuitry provides synchronous receive character clock for the MPU receive data interface normally supplied by the AFSATCOM Type 12 terminal. The microcomputer system does not use the RX character clock signal supplied by the AFSATCOM modem. However, for proper AFSATCOM operation, this clock is reconstituted and supplied to the MPU input circuitry.

5.4.4 Memory I/O Address Decoder/Acknowledge

Figure 5-7 shows the memory I/O address decoder/acknowledge circuit. Its primary function is to generate select signals for memory address decoding for a pair of Motorola MC6852 serial data adapter ICs. These select signals, along with the memory acknowledge signal, permit the ICs to be utilized as if they were an inherent part of the SBC 80/20 memory addressing space. Read or write operations to these devices then use the memory addresses which serve these two ICs.

5.4.5 TX Character Deletion

The TX character deletion circuit, shown in figure 5-8, deletes two redundant message characters encountered with the MC6852 IC used in conjunction with the AFSATCOM modem transmit interface. Actual transmit character deletion takes place before the start of transmission to the modem and occurs only during the time interval when the AFSATCOM modem is in the process of transmitting its own "W U SYN SYN" preamble.

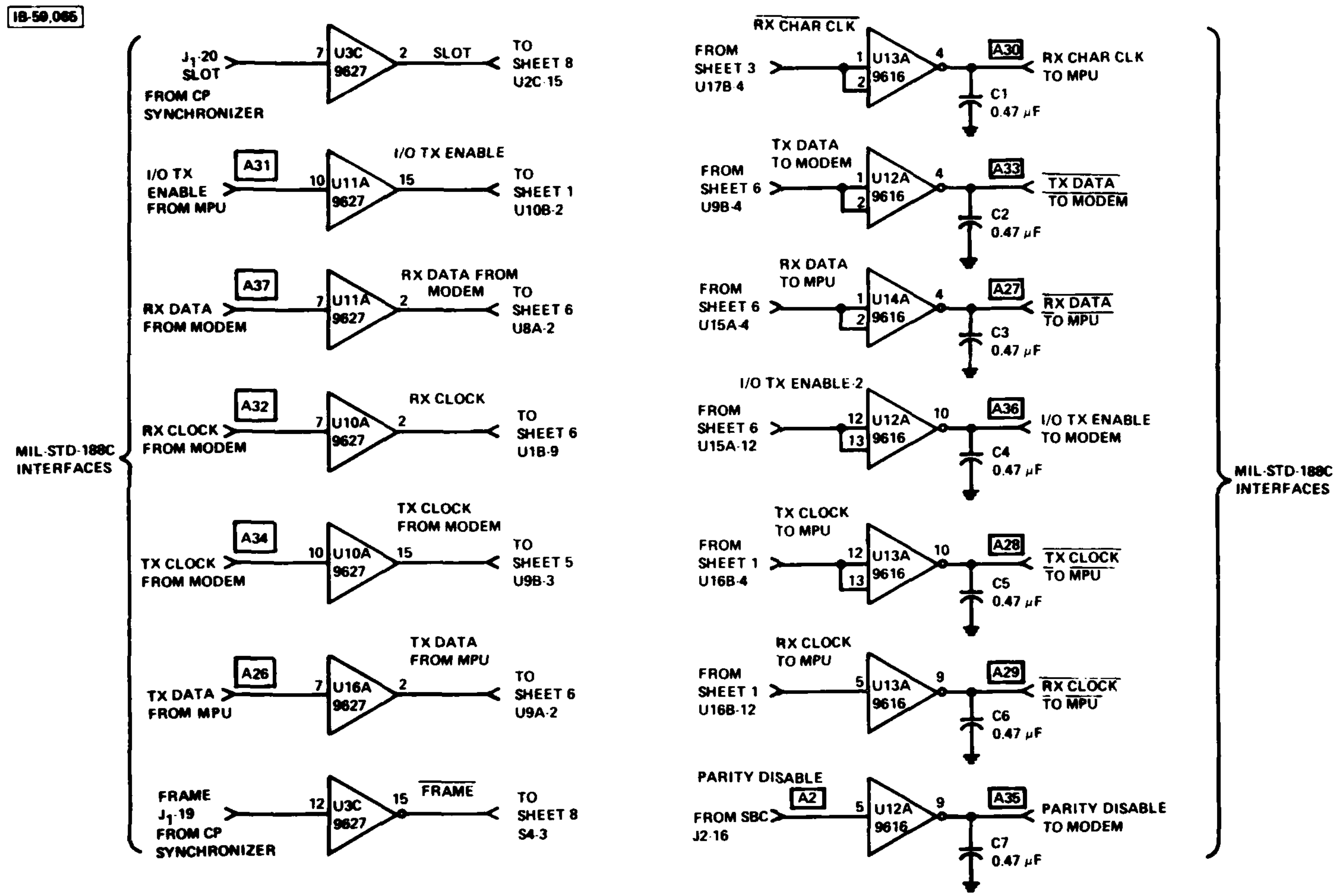


Figure 5-5 External I/O Interface (Sheet 2)

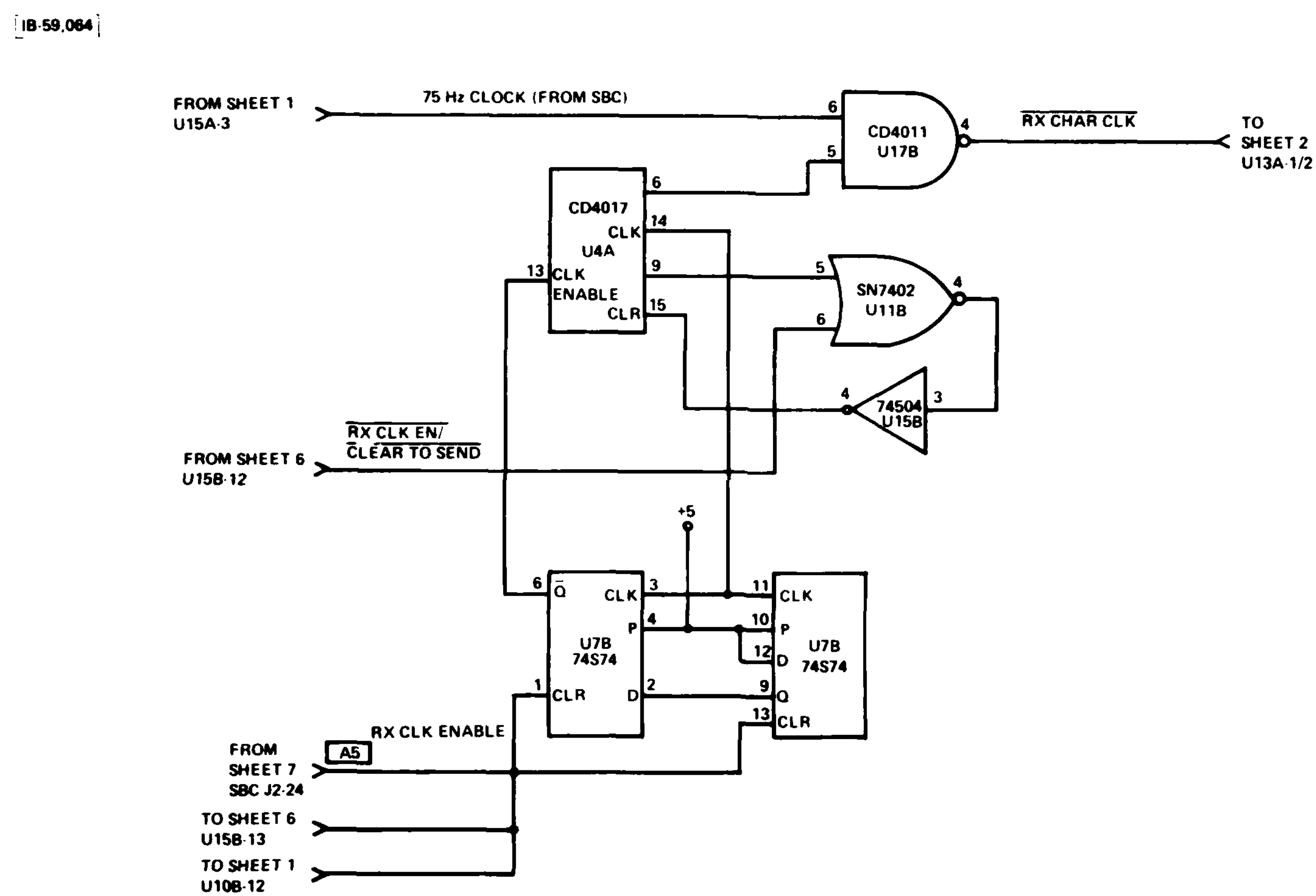


Figure 5-6 RX Character Clock Generator (Sheet 3)

IB 59,082

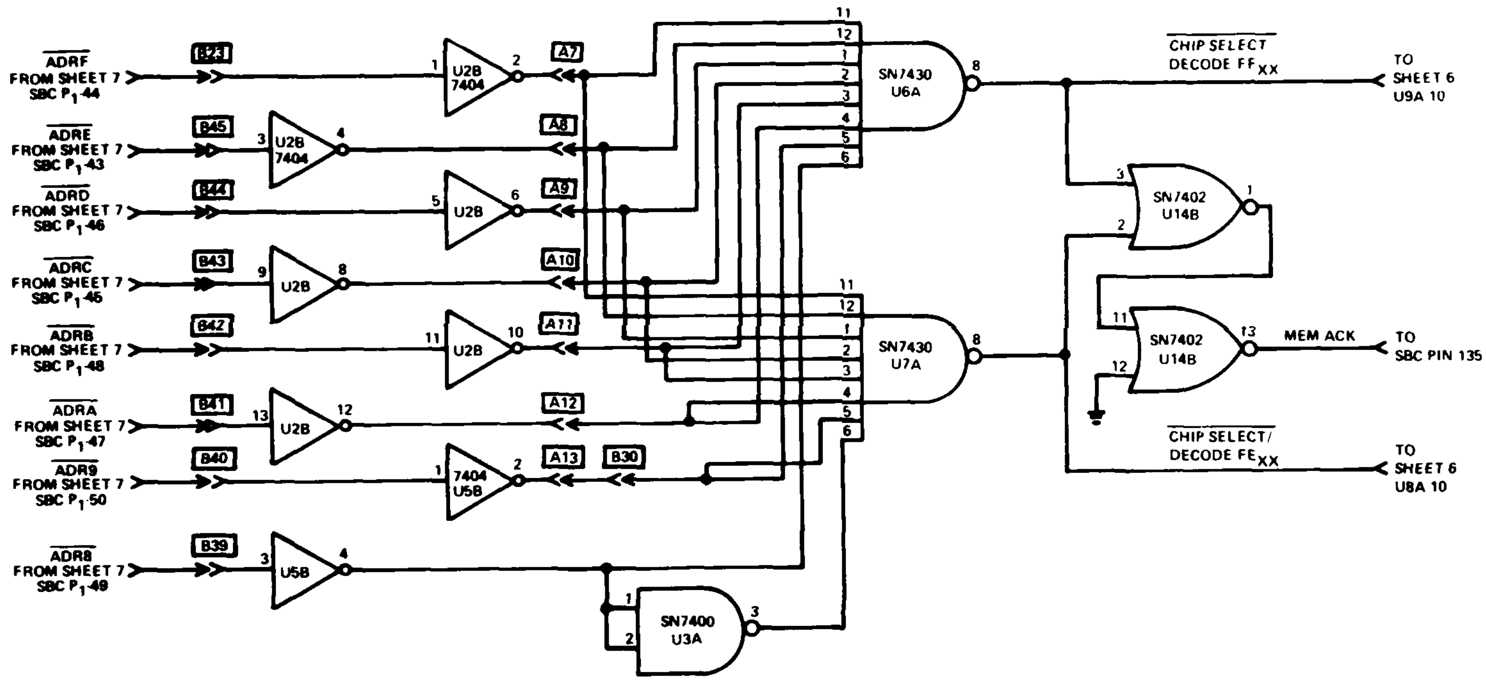


Figure 5-7 Memory I/O Address Decoder/Acknowledge (Sheet 4)

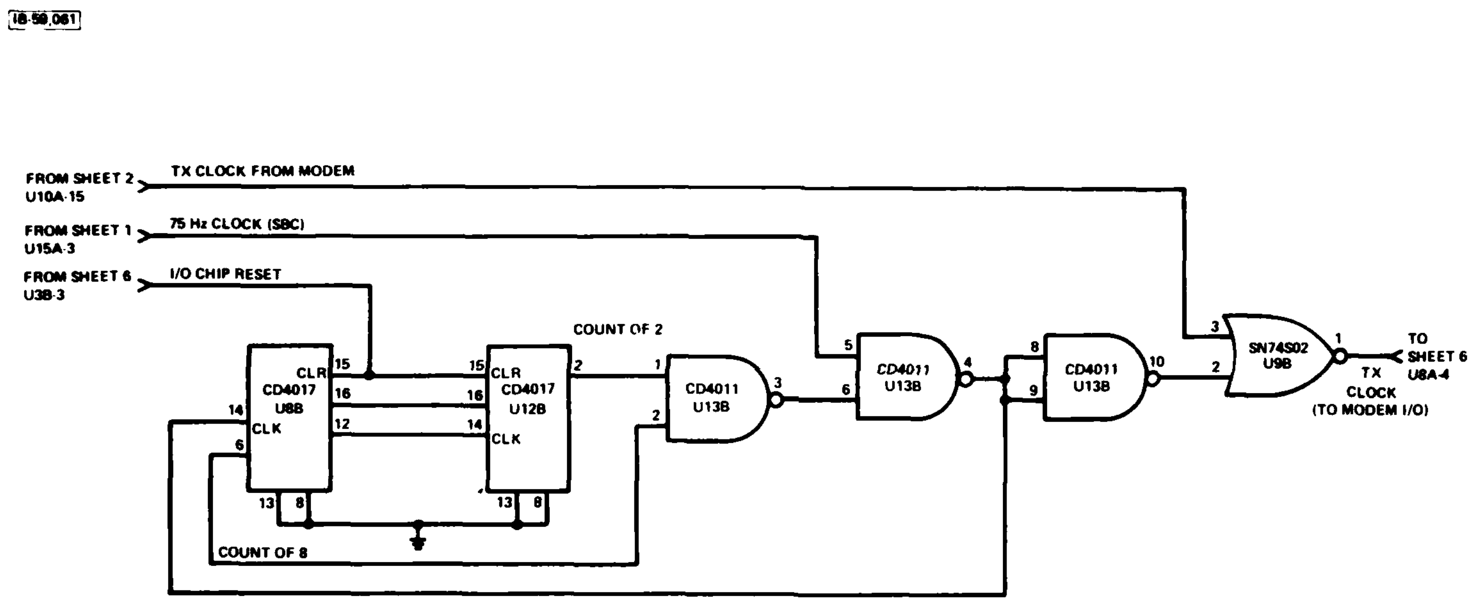


Figure 5-8 TX Character Deletion (Sheet 5)

5.4.6 Modem/MPU-to-SBC Serial Data Adapter

Figure 5-9 shows the modem/MPU-to-SBC serial data adapter circuit. Its primary function is to transfer serial data to/from the AFSATCOM modem or MPU to/from the SBC 80/20. The SBC 80/20 reads or writes these data as if they were located in a memory address. Selection of either the modem I/O or MPU I/O takes place via a register select line with read/write operations controlled separately.

The heart of this circuitry consists of a pair of Motorola MC6852 programmable synchronous serial data adapter (SSDA) ICs. Each provides a three-character buffered bi-directional serial interface for synchronous data exchange. The MC6852 design incorporates bus interface logic to allow parallel data transfer over the SBC 80/20 bi-directional parallel data bus. The actual configuration of the SSDA is programmed via the data bus using the polling program system initialization software. SSDA internal programmable control registers provide word length, transmit, receive, synchronization, and interrupt controls. Status, timing, and other SSDA control lines provide additional peripheral or modem functions.

5.4.7 SBC 80/20 Interfaces

Figure 5-10 summarizes the I/O and display interfaces within the microcomputer system. Jumpers and parallel terminations employed, along with physical board modifications for the SBC 80/20, are indicated.

5.4.8 Slot Counter/Display

Figure 5-11 shows the slot counter/display circuit interfaces to the SBC 80/20 and the I/O circuits. Slot pulses from the AFSATCOM synchronizer are used to increment the slot display on a pair of Texas Instruments TIL 306 ICs while the frame pulse from the synchronizer (or a manual toggle switch) provides a reset function back to zero slot indication. A pair of four-bit binary coded decimal (BCD) output lines (8 parallel lines, total) to one of the SBC 80/20 parallel input ports is used by the polling software in calculating the current AFSATCOM slot. As implemented in the demonstration system software, zero-slot indications signal the non-TDM AFSATCOM mode and non-zero indications signal TDM operation.

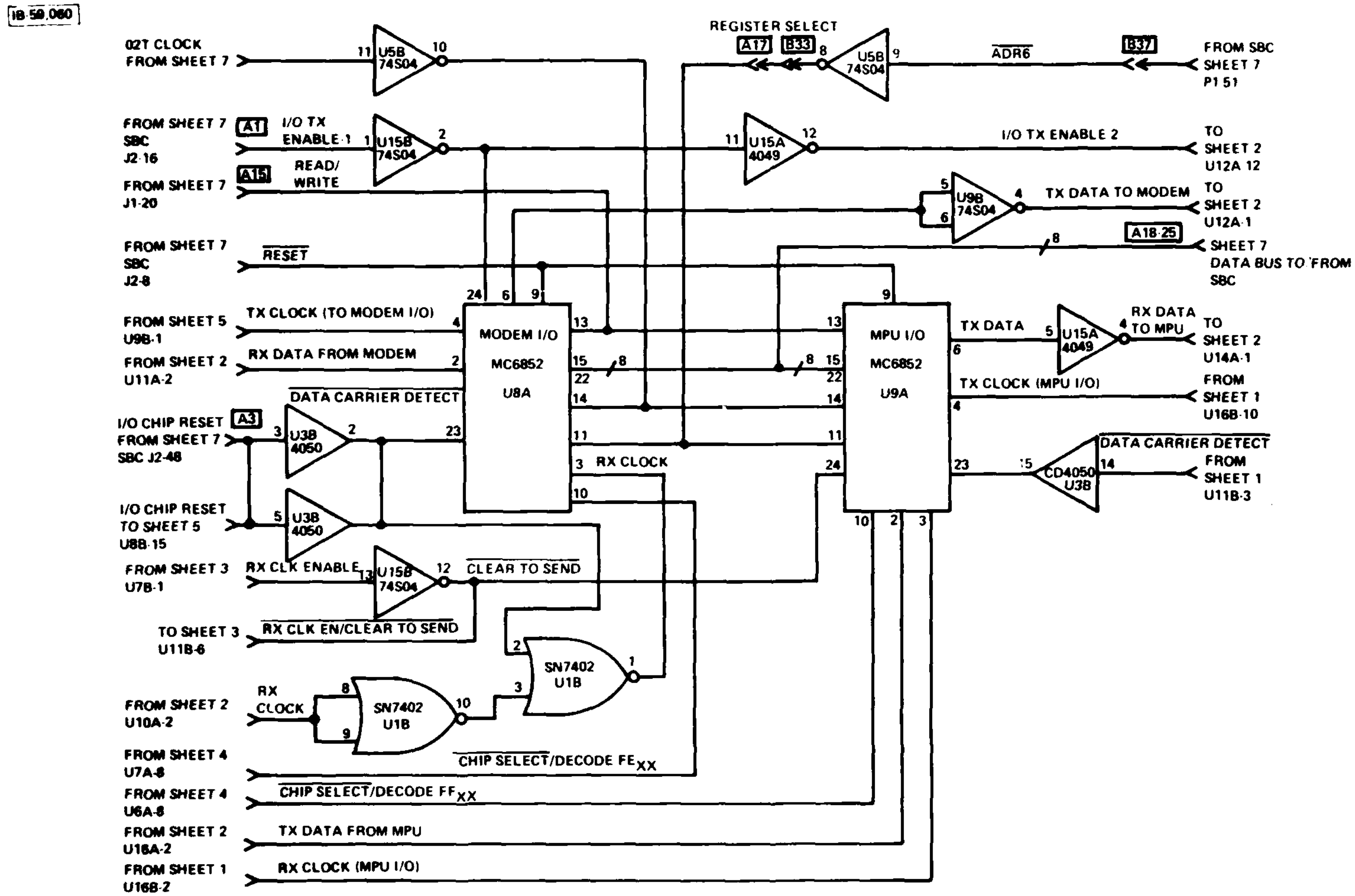
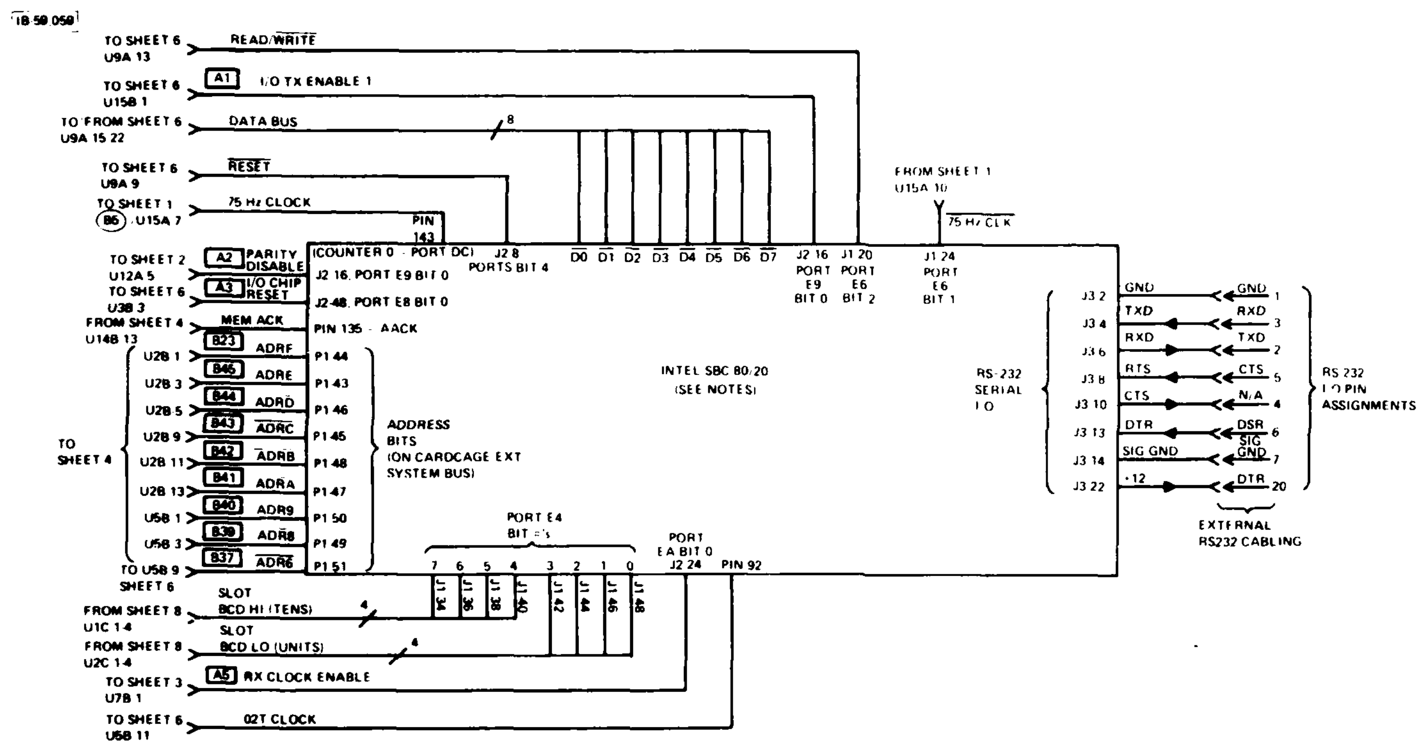


Figure 5-9 Modem/MPU-to-SBC Serial Data Adapter (Sheet 6)



NOTES

1) PORT TERMINATIONS

PORT TERMINATIONS	PIN # JUMPERS/ICs
A3 (PORT E6 HI)	8 9 10 (ON COMPONENT HOLDER)
A4 (PORT E6 LO)	1 2 3 (ON COMPONENT HOLDER)
A5 (PORT E5 LO)	1 2 3 (ON COMPONENT HOLDER)
A9, A10, A11, A12	SN7408A

2) SBC PIN # JUMPERS

51 52
70 71
128 129
16 18 } RS232
19 21 } I/O
3 4

3) Y1 REPLACED BY 6700 kHz CRYSTAL TYPE FT 243

4) 0.02 μF DISC CAPACITOR ADDED IN SERIES WITH C53

5) UNUSED IC LOCATIONS
A35 36 38 39 49 50 62 63

6) ON BOARD 2708 EPROM LOCATIONS
A79 (PROM 0) A64 (PROM 1)
A51 (PROM 2) A37 (PROM 3)

Figure 5-10 SBC 80/20 Single Board Computer Interfaces (Sheet 7)

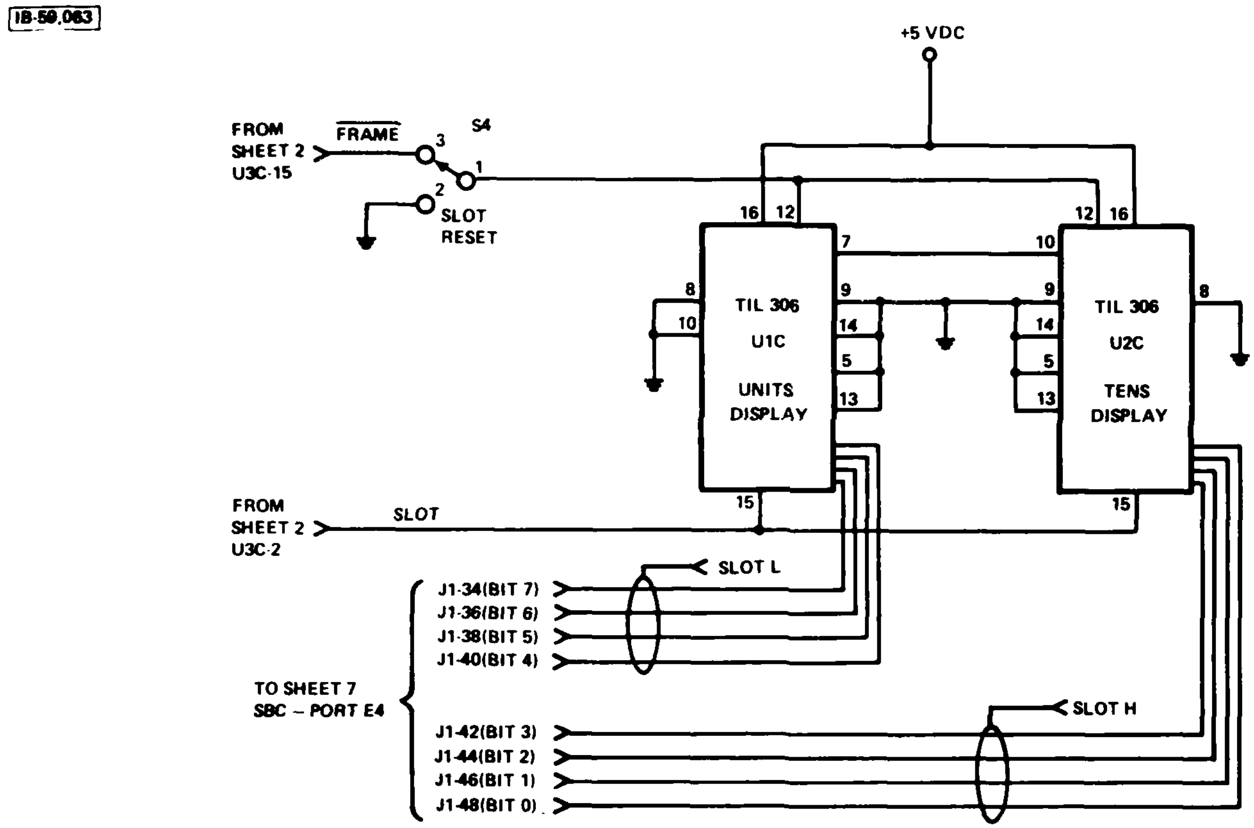


Figure 5-11 Slot Counter/Display (Sheet 8)

5.4.9 RS-232 Serial Interfaces

Figure 5-12 summarizes the cable interfaces employed with the microcomputer system and made possible by serial RS-232 interface circuitry which employs a software-programmable 8251 USART IC on the SBC 80/20 card. Shown are cable interfaces for use with a Bell 103J modem, a "NULL" modem, a Lear Siegler ADM-3A CRT terminal, and a Texas Instruments Model 765 Intelligent Terminal.

When the polling software is commanded into its RS-232 mode, all messages normally routed to the AFSATCOM MPU interface are rerouted to the RS-232 serial interface port at a 300 b/s rate (instead of 75 b/s). Messages destined for transmission to the AFSATCOM modem or COMSUP commands normally originating at an AFSATCOM ASR device may now be entered into this RS-232 interface. While in this mode, the AFSATCOM ASR may still be used for all transmitting functions; however normal reception from the OW (or NB-1) channel will be diverted to this RS-232 port. When not in the RS-232 mode, normal NB interfaces to the MPU are utilized.

5.5 MODULAR RACK HARDWARE FEATURES

When the microcomputer rack assembly is installed in the Type 12 terminal, two multi-pole bypass switches mounted on the front panel can disengage the microcomputer system from the MPU, NB modem, and synchronizer interfaces without physical removal of connectors. Connector terminations on the rear of the rack provide convenient access for cables to the AFSATCOM Type 12 CP terminal.

The modular rack assembly is designed for ease in removing all mounted components and subsystems. Test points mounted on the front panel of the rack also provide a convenient access to all interfaces for ease in trouble-shooting. Front panel fuses on the rack serve to protect the various power supplies in the power supply subsystem. An on-off power line switch and a line voltage indicator are below these fuses.

Finally, a slot display reset switch and eight BCD slot selection switches are also front-panel mounted for convenient control of polling test functions related to TDM and non-TDM modes.

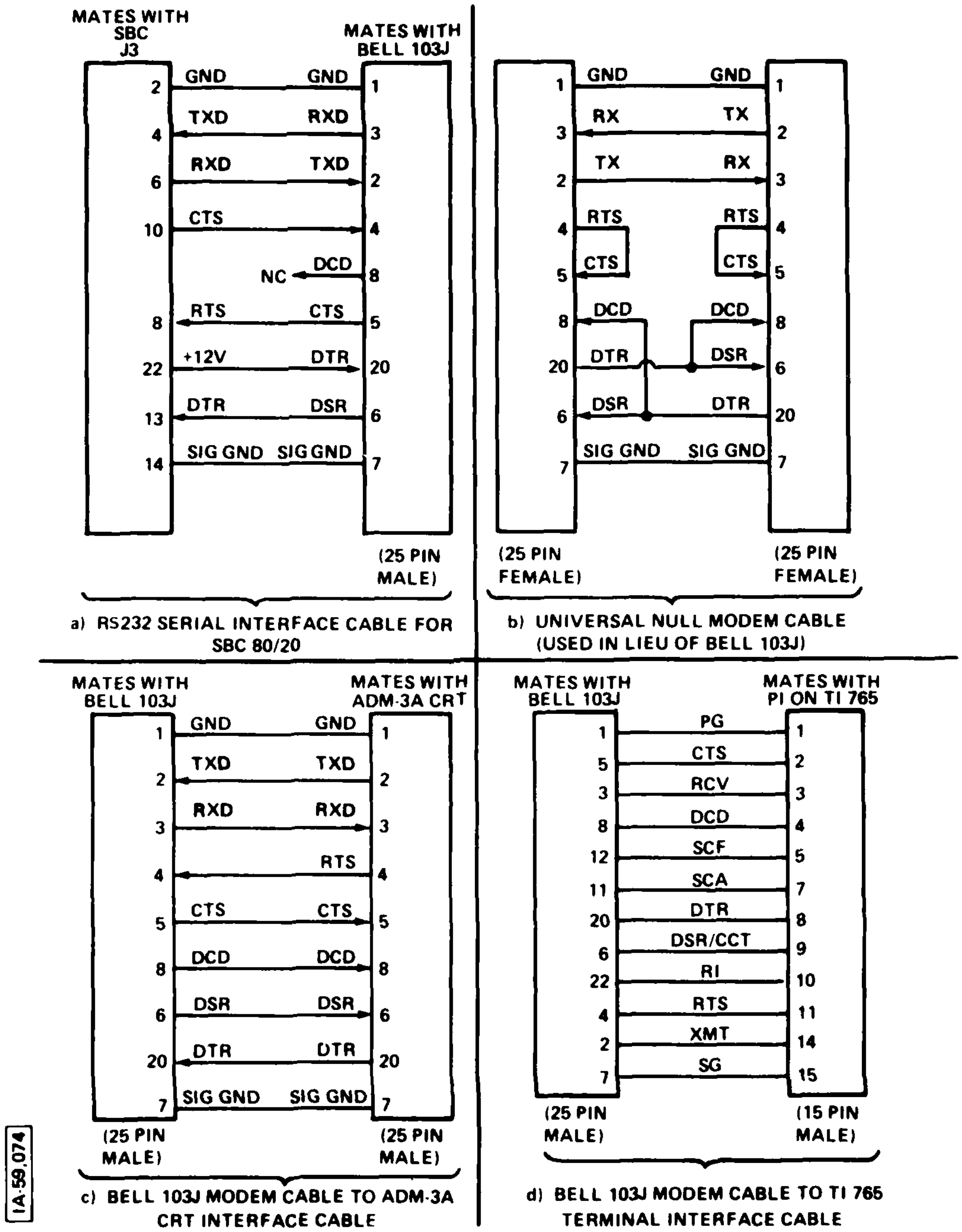


Figure 5-12 RS-232 Serial Interfaces

SECTION 6

MICROCOMPUTER SOFTWARE

Figure 6-1 shows the major elements of the microcomputer facility at MITRE-Bedford which was used for overall software development for the polling improvement project. The Tektronix 8002A software development system and the MITRE Time Sharing Option (TSO) system assets related to polling software development are described below.

The microcomputer software for the improved polling demonstration capability was written in PL/M-80 high-level language on TSO. The PL/M-80 source coding, which is essentially self-documenting, takes advantage of modular interrupt-free, structured programming techniques and attempts to minimize (but not entirely eliminate) interactions between the various modular segments of the overall program.

After appropriate compilation and debug on TSO, followed by downloading to the Tektronix 8002A microprocessor laboratory, executable code was installed in the microcomputer system using 2708 EPROM non-volatile memory ICs. Execution of this code in the microcomputer system provides the processing functions needed to satisfy the polling enhancements described in section 4.

6.1 FLOW CHARTS

The polling software for the microcomputer system is functionally described by the flow chart of figure 6-2. Following power turn-on of the microcomputer system, the software executes the Initialization Sequence, followed by the main program loop starting at the Slot Calculation Algorithm and ending at the TX Output Algorithm. Return to the Initialization Sequence is also possible by means of a software re-initialization COMSUP command. Unless the software is re-initialized, however, normal program execution continues in this endless loop. The time-to-completion of a single cycle within this loop is typically less than a single character interval at the AFSATCOM 75 b/s rate. Coupled with this capability is a three-character buffer in the serial synchronous MPU and modem interfaces employed for use with the AFSATCOM hardware (see subsection 5.4.6) which avoids loss of data during program execution in an interrupt-free manner.

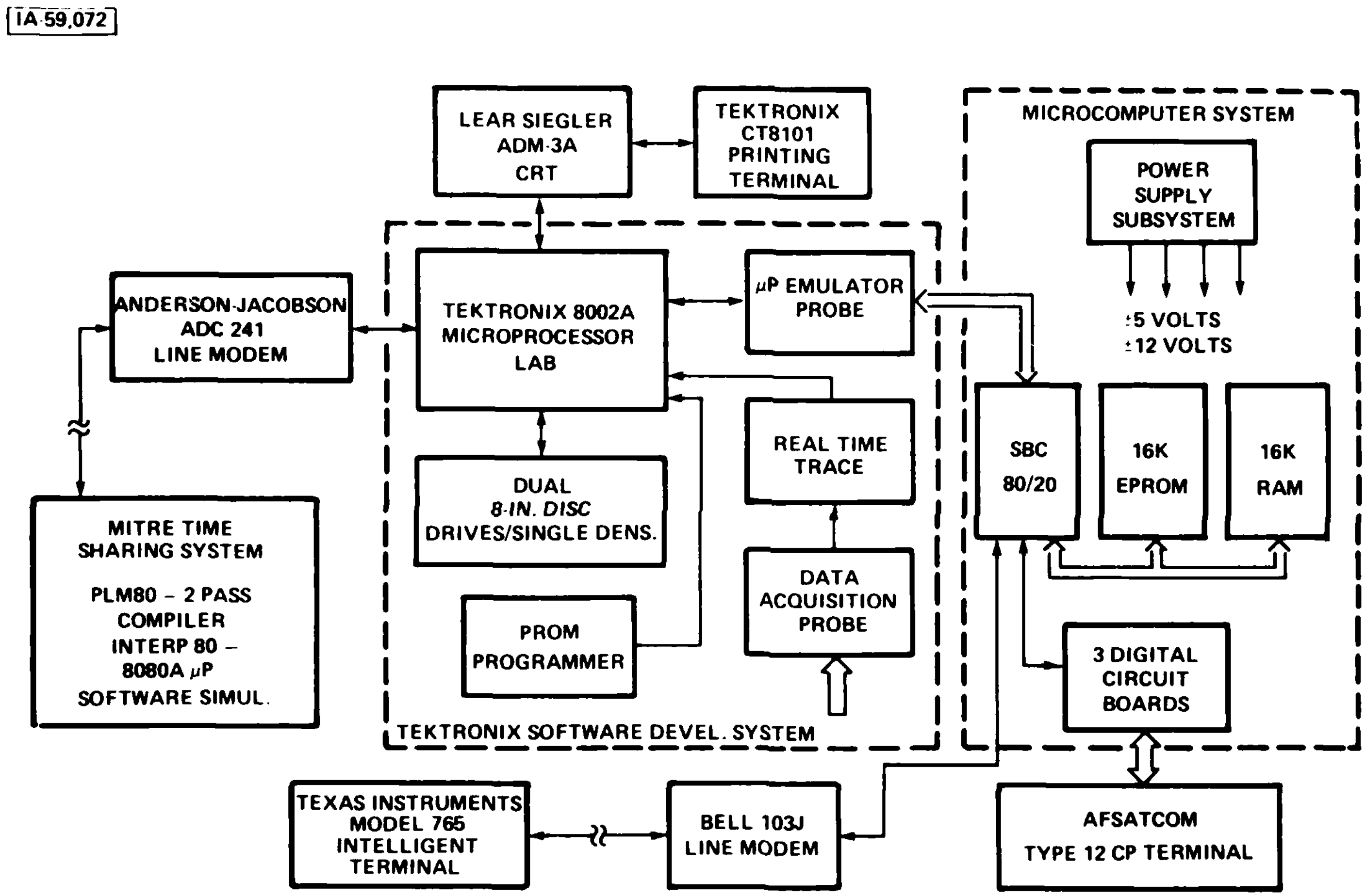


Figure 6-1 Microcomputer Development Facility

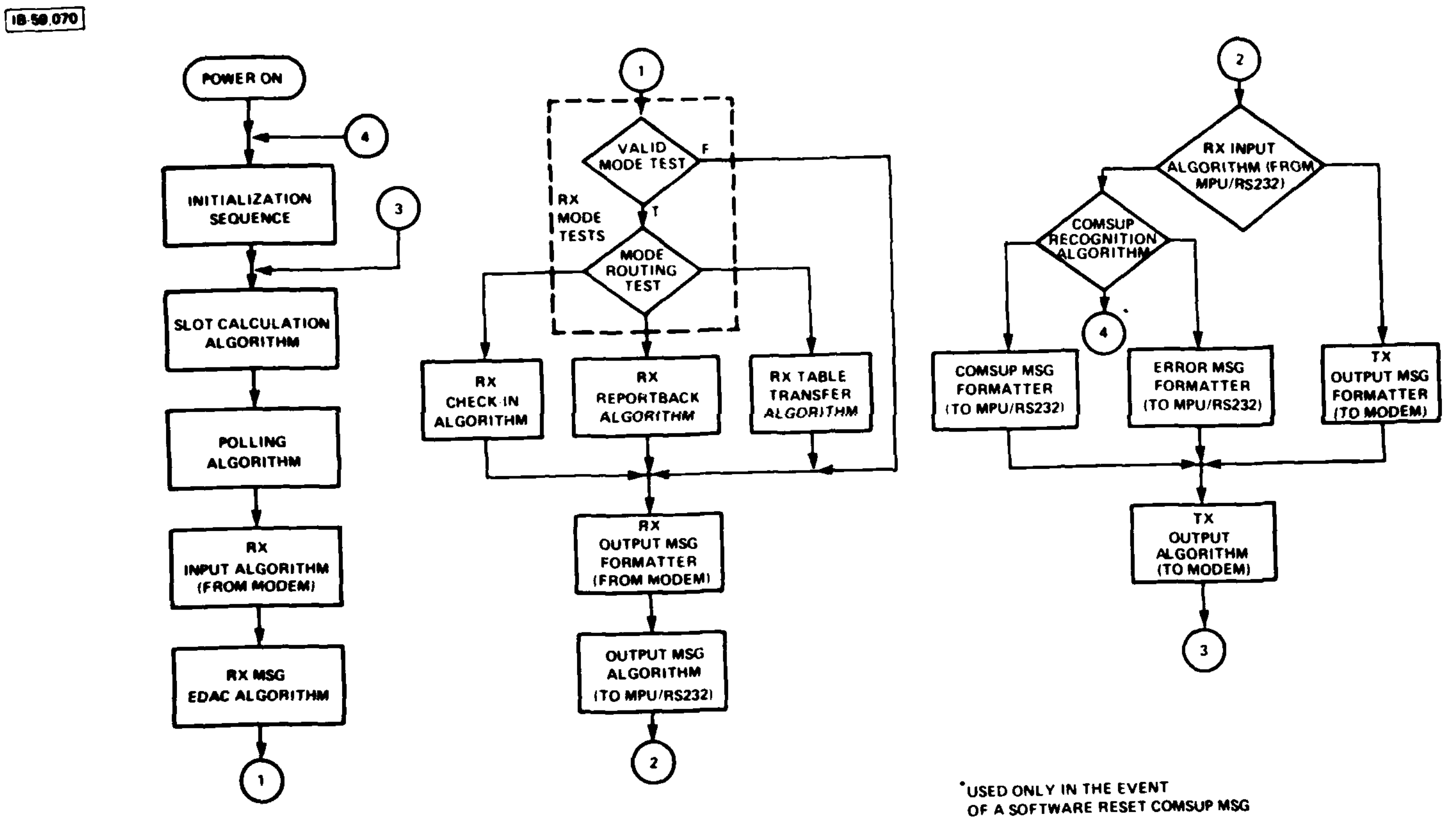


Figure 6-2 Polling Software Program Flowchart

Table 6-1 describes the various program modules along with their major performance characteristics during program execution. The polling algorithm is the heart of the overall polling program software; a more detailed flow chart of this polling algorithm is provided in figure 6-3.

6.2 PL/M-80 SOURCE CODE AND MEMORY ALLOCATIONS

Table 6-2 contains the improved polling software symbol table and memory map which identifies RAM and ROM (EPROM) label locations, variables, and constants used throughout the software. This table is consistent with the program module PL/M-80 labels shown in table 6-1 and the address locations in table 5-1 so that the start of each major program module may be readily identified. This also allows ease in modifying or upgrading existing software by appropriate EPROM replacement within the microcomputer system. Appendix B contains the actual PL/M-80 source code which was written on TSO.

6.3 MITRE TSO SYSTEM PL/M-80 SUPPORT

PL/M-80 assets available on TSO which were utilized for the microcomputer software development are described below.

6.3.1 PL/M-80 High Level Language

PL/M-80 is an advanced high level programming language available on the MITRE TSO system. Specifically designed to simplify the job of system programming for the Intel 8080 8-bit microprocessor, it provides a very effective software development and maintenance tool, well suited to the requirements of the microcomputer system designer. PL/M-80 is also easy to learn and facilitates rapid program development and debugging since it is an algorithmic language in which the program consists of a sequence of declarations and executable statements naturally expressing the algorithm to be performed. Thus, the programmer is free to concentrate on system development through use of modern structured programming techniques at a high level, rather than dealing with assembly language details (such as register allocation, etc.). For a complete description of PL/M-80 see reference 3.

6.3.2 PL/M-80 2-Pass Cross-Compiler

The 8080 PL/M cross-compiler consists of two distinct programs which must be executed consecutively to perform a complete

Table 6-1

Program Software Module Description

Module	Label(s)	Functions
Initialization Sequence	Program$Start	Defines I/O port parameters, declares/initializes constants/variables; initializes key memory locations; initializes SBC programmable counters; defines I/O memory locations.
Slot Calculation Algorithm	IPOLL I	Calculates current slot; sets TDM mode flag; converts BCD input from slot display to decimal using conversion algorithm.
Polling Algorithm	POLL$XMIT	Checks poll mode flag; checks for polling completion; checks for TDM or non-TDM polling mode; checks for poll interrupt; signals completion of polling; updates EDAC table entry during non-TDM polling.
RX Input Algorithm	IPOLL II	Tests RX input buffer character status of I/O chip; fetches RX character when available; tests for last character received state; tests for RX buffer memory overflow; tests for encrypted mode initialization sequence; tests mode/address characters for subsequent processing sequence (sets MPU job flag).
EDAC Algorithm	EDAC$ROUTINE	Provides EDAC for polling messages transmitted via downlink RX monitoring. (If EDAC criteria are satisfied, sets retransmit flag for a non-TDM mode polling message for up to three retransmissions.)
RX Mode Tests	MJT2	Tests RX mode characters from modem for check-ins, reportbacks, and table transfers; provides routing to various RX mode algorithms.

Table 6-1 (Continued)

Program Software Module Description

Module	Label(s)	Functions
RX Check-in Algorithm	CS$TEST	Identifies invalid check-ins from modem; logs valid check-ins into appropriate check-in tables; composes output message for MPU with appropriate check-in headers; formats overflow message when check-ins are at limit for MPU (and also for modem when poll mode is not active); automatically cancels check-in mode when check-ins are at limit.
RX Reportback Algorithm	PRB$LOAD RRB$LOAD NRB$LOAD	Composes output message to MPU with appropriate report-back header when a valid reportback is received from modem.
RX Table XFER Algorithm	PTT$LOAD RRB$LOAD NTT$LOAD	Identifies invalid table transfers received from the modem; logs valid table transfers into appropriate check-in tables; composes output messages to MPU with appropriate table transfer headers; formats overflow messages when check-ins are at limit for MPU (and also for modem when poll mode is not active); automatically cancels check-in mode when check-ins are at limit.
RX Output Msg Algorithm	MPU$TABLE$BUILD	Checks if message delay is active; increments delay counter as required if msg delay is enabled; verifies need to output a message; checks availability of buffer space for outputting a character, outputs data to either MPU output (memory I/O) or RS-232 I/O port, depending on which is activated; shifts down internal storage buffer upon completion of message transmittal; enables clock output to MPU on start of message transmittal and disables it on completion.

Table 6-1 (Continued)

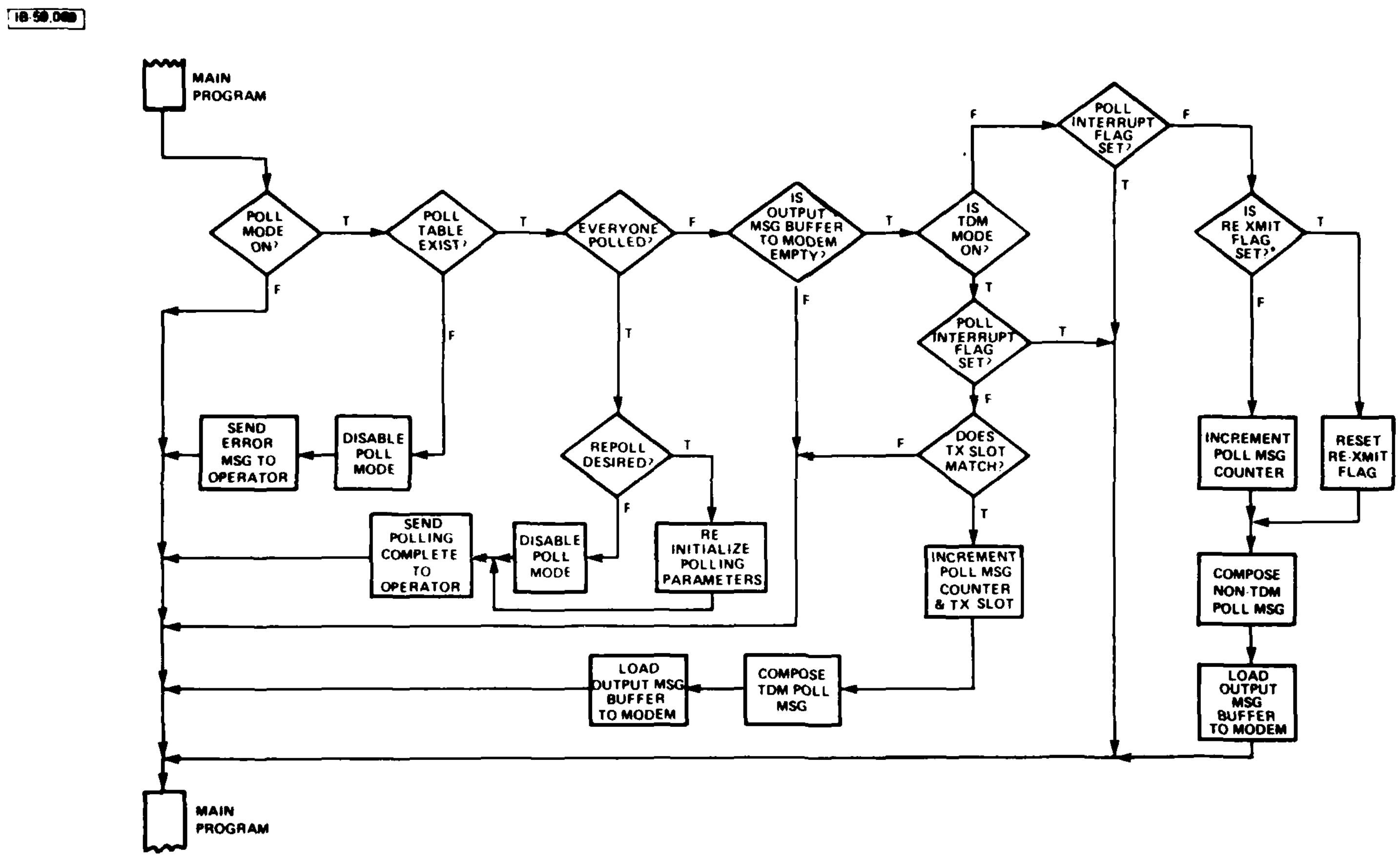
Program Software Module Description

Module	Label(s)	Functions
RX Input Algorithm	IPOLL101	Tests receive input buffer character status of RS-232 I/O if activated; fetches character if available; tests receive input buffer character status of I/O chip; fetches character if available; tests for last character status; tests for buffer overflow; tests for valid commands and determines processing sequence by setting an output flag; determines when complete message has been received; verifies need to ignore all but command-type messages.
COMSUP Recognition Algorithm	COMPOSE1	Checks for correct command-type message lengths; validates receipt of correct address characters; identifies various mode and address errors, checks for valid command-type mode characters; routes command-type message to appropriate command message algorithms.
COMSUP Msg Formatter (To MPU/RS-232)	COMSUPLOAD1	Formats command-type messages to MPU input or RS-232 I/O interface.
Error Msg Formatter (To MPU/RS-232)	MODEERROR1 ADRERROR1 OVERFLOW1 OVERFLOW2 TFRERROR1	Formats appropriate error messages to MPU input or RS-232 I/O interface.

Table 6-1 (Concluded)

Program Software Module Description

Module	Label(s)	Functions
TX Output Msg Formatter (To Modem)	MODEM$OUTPUT$-COMPOSE1 MODEM$OUTPUT$-COMPOSE2	Formats output messages to modem; deletes first three characters upon recognition of special character in position #4; resets output flag for modem messages.
TX Output	OPOLL101	Checks if message delay is activated; increments appropriate delay counter as required if delay is active for TDM and non-TDM modes; verifies need to output a message; monitors state of receive input messages from modem to avoid transmitting while messages are received; signals modem when message is ready for transmission; shifts down internal storage buffer on completion of message transmittal.



*FLAG SETTING OCCURS IN ERROR DETECTION AND CORRECTION (EDAC) SOFTWARE ALGORITHM

Figure 6-3 Polling Algorithm Flowchart

Table 6-2

Symbol Table and Memory Map

Name	Location (Hex)	Name	Location (Hex)
ADR1	4638	CLK3	4662
ADR2	4639	CLKCNT	5792
ADR3	463A	CLKCNT1	4664
ADRCHANGE	1B80	CLKCNT2	4666
ADRERROR1	1D67	CLKCNT3	4668
ADRERRORHDR	037C	CLKP	579A
AUTOPOLLRESTART	0611	CLKP1	465E
AUTOREPOLLFLAG	4684	CLKP2	4661
BUFFERDELAY	579C	CLKP3	4663
BUFFERDELAY1	466A	CMODE	6661
CC	6668	CMODECANCEL	0D99
CC1	5760	CMODECANCEL1	0DFC
CCPRESENT	4658	COMPOSE1	17FF
CC1PRESENT	465A	COMSUPLOAD1	296F
CCTEST	0B25	CS	5775
CHAR	5776	CS1	4688
CHAR1	4689	CS3	464A
CHAR3T	0998	CS4	464B
CHAR4T	09B1	CSDATAPOINTER	5764
CHAR4T1	166B	CS1DATAPOINTER	576C
CHAR5T	09CA	CSTEST	0B13
CHARSTORE	5D64	DELAY	579B
CHARSTORE1	468E	DELAY1	465F
CHECKINDELETE	247A	DELAYCAL	1D3A
CHECKINMODESET1	28D5	DELAYROUTINE	1442
CINUMTEST	0D76	DELAYROUTINE1	03D7
CLK	5799	EATMSG1	1773
CLK1	465D	EATMSGFLAG1	465C
CLK2	4660	EATMSGSET	1AF3

Table 6-2 (continued)

Name	Location (Hex)	Name	Location (Hex)
EDACFLAG	4656	INPUT5DATAPOINTER	5768
EDACMODESET	1B4A	INPUT103DATAPOINTER	576E
EDACROUTINE	0A33	INPUT105DATAPOINTER	5770
ENC	5777	J	5762
ENCRYPT	0937	LCT	09E0
ENCTEST	0904	LCT1	1685
ENDLOAD	3833	LINECOUNT	468D
EOMTEST	13E0	LOADADR	37A1
EOMTEST1	3D3F	MEMORY	7400
ERRORHDR	039A	MJF	5778
GC	08BD	MJT1	093E
GC1	1614	MJT2	0AC7
GCIPOINTER	578C	MODE	5779
GCIRESET	2960	MODEERROR1	2A08
GCISTORE	5C23	MODEMIOCTL1POINTER	4632
GPOLLBUILD1	3C92	MODEMIOCTL2POINTER	4634
GT1	2278	MODEMOUTPUTCOMPOSE1	1700
GTABLEBUILD1	3548	MODEMOUTPUTCOMPOSE2	1783
GTABLEDUMP1	34C1	MPUCINUMTEST1	2824
GTDHEADER	0362	MPUIOCTL1POINTER	462E
I	6662	MPUIOCTL2POINTER	4630
I1	575A	MPUTABLEBUILD	0E58
INITIALMSG	0461	MSGCOUNT	6534
IPLTEST	1915	MSGCOUNT1	4E5E
IPOLL1	04BF	MSGDELAY	579E
IPOLL11	087C	MSGOVERDELAY	4672
IPOLL101	15A8	N	577C
IPOLL1011	15D4	NC	5786
INPUT3DATAPOINTER	5766	NCIHEADER	02CD

Table 6-2 (continued)

Name	Location (Hex)	Name	Location (Hex)
NCIPOINTER	5790	OPOLL1	13BB
NCIRESET	2945	OPOLL101	3D1A
NCISTORE	5AA2	OUT1	468A
NCITEST	0CC8	OUTCHAR	148C
NOCOMSUPLOAD1	29FD	OUTCHAR1	3EA7
NONTDMDELAY1	3DF6	OUTCOUNT	6666
NONTDMDELAYSET	1CD2	OUTFLAG1	1680
NONTDMMSGDELAY1	466C	OUTPUTCOMPOSE	16CF
NONTDMPOLL	0622	OUTPUT1DATAPOINTER	576A
NPOLLBUILD1	3C12	OUTPUT101DATAPOINTER	5772
NRBHEADER	02E1	OUTTABLE	666B
NRBLOAD	0F9A	OUTTABLE1	4F8A
NT1	2201	OUTTABLEBUILD	0E64
NTABLEBUILD1	339B	OUTTABLE1STATUSTEST	05E9
NTABLEDUMP1	3314	OVERFLOW1	2847
NTDHEADER	0343	OVERFLOW2	284C
NTDMDELAYH	467C	OVERFLOWHDR	03D9
NTDMDELAYL	467E	PCIHEADER	0241
NTDMEDACTABLE	464F	PCIPOINTER	5784
NTDMPOLLINTERRUPTFLAG	4686	PCIRESET	292D
NTTHEADER	02F5	PCISTORE	57A0
NTTLOAD	1278	PCITEST	0B43
NTTLOAD1	200A	POLLDUMPBUILD1	372F
NTTLOADEND	1348	POLLDUMPHDR	03F4
NTTR1	2CEB	POLLFLAG	4683
NUMGCI	577E	POLLINGMODETEST	05FF
NUMMCI	578E	POLLINTERRUPT	1C5B
NUMPCI	5782	POLLMODE	1BB4
NUMRCI	5788	POLLMODEERROR	0550

Table 6-2 (continued)

Name	Location (Hex)	Name	Location (Hex
POLLMSGCOMPLETE	0580	PTABLEBUILD1	3042
POLLMSGCOUNT	464C	PTABLEDUMP1	2FBB
POLLMSGOVER	0410	PT1COUNT1	73FE
POLLOVERTEST	0558	PTDHEADER	030A
POLLPOINTER1	73FC	PTTHEADER	02E5
POLLSLOT1H	463B	PTTLOAD	0FF3
POLLSLOT2H	463C	PTTLOAD1	1E3D
POLLSLOT3H	463D	PTTLOADEND	10C2
POLLSLOT4H	463E	PTTR1	2B45
POLLSLOT5H	463F	QUIT	3FAB
POLLSLOT6H	4640	RCIHEADER	02C9
POLLSLOT1L	4641	RCIPOINTER	578A
POLLSLOT2L	4642	RCIRESET	293E
POLLSLOT3L	4643	RCISTORE	5921
POLLSLOT4L	4644	RCITEST	0C05
POLLSLOT5L	4645	REPOLLFLAGCOUNT	4657
POLLSLOT6L	4646	REPOLLTEST	0572
POLLTABLE1	6E3B	RETRANSMITFLAG	4676
POLLTABLEBUILD1	3B34	RETRANSMITFLAGSET	0AAD
POLLTABLEDUMP1	36B1	RPOLLBUILD1	3B96
POLLTABLEDUMP2	366E	RRBHEADER	02DD
POLLTABLETX	3A3E	RRBLOAD	0F41
POLLTABLETXFLAG	4685	RS232FLAG	4637
POLLTTR1	2DBE	RS232GC1	161D
POLLXMIT	0530	RS232INPUT1	15B9
PRBHEADER	02D1	RS232MODESET	1ABD
PRBLOAD	0EE8	RS232OUTCHAR	14B1
PROGRAMSTART	0007	RS232SPACETEST	1427
PT1	2114	RT1	218A

Table 6-2 (concluded)

Name	Location (Hex)	Name	Location (Hex)
RTABLEBUILD1	31EE	TCLK	466F
RTABLEDUMP1	3167	TCLK1	4673
RTDHEADER	0327	TCLKCNT	4671
RTTHEADER	02F1	TCLKCNT1	4675
RTTLOAD	1135	TCLKP	4670
RTTLOAD1	1F23	TCLKP1	4674
RTTLOADEND	1205	TDMDELAYROUTINE1	3DB3
RTTR1	2C18	TDMFLAG	4682
RXBUSYOVERRIDE1	3E60	TDMPOLL	0739
SHIFTDOWN	14C8	TDMPOLLINTERRUPTFLAG	4687
SHIFTDOWN1	3EC2	TDMPOLLTXSLOT	4677
SLOT	467A	TDMPOLLTXSLOTINITIAL	4649
SLOTCOUNT	467B	TFRERROR1	2E7B
SLOTGUARDTIME	4680	TFRERRORHDR	03B8
SLOTH	4678	TOTALNUMCI	5780
SLOTL	4679	TTLOADEND1	20F1
SLOTREASSIGN	19AD	TTR1	2A94
SPACE	577B	TXSLOTINITIALH	4647
SPACE1	468C	TXSLOTINITIALL	4648
SPACETEST	1401	WAITING	577A
SPACETEST1	03D5	WAITING1	468B
ST	0916	WW	08A7
STARINSERT	0B1C	XX	089B
STARTUPMSG	042E	YY	15F2
TBLDUMP1	2EE1	ZZ	15FE
TC	6664		
TC1	575C		
TCINITIAL	5794		
TC1INITIAL	5796		

compilation of a PL/M source program. The two programs are known as Pass 1 (PL/M-81) and Pass 2 (PL/M-82) of the PL/M compiler. They are written in ANSI standard Fortran IV and are installed on the MITRE TSO system.

The first pass of the compiler reads a PL/M source program and converts it to an intermediate form on work files. As an option, a listing of the input source program may be obtained during this pass. Errors in program syntax are detected at this stage and appropriate error messages are sent to the list file.

The second pass of the PL/M compiler processes the intermediate files created by Pass 1 and generates machine code. This machine code, which can be in either BNPF or hex format, may be loaded and executed on the SBC 80/20 microcomputer, on the Tektronix 8002A, or simulated using INTERP/80, a cross-simulator of the 8080 microprocessor unit. It may also be used for programming ROMs. Pass 2 of the compilation process can produce a symbol table and mnemonic listing of the generated machine code. Errors detected during this phase will be reported in the list file which is produced.

Figure 6-4 illustrates the overall file structure and flow of program execution of the PL/M cross-compiler available at MITRE. For a complete description of the PL/M-80 2-pass cross-compiler see reference 4.

The run-time organization of the memory storage allocation for a compiled PL/M-80 object program is shown in figure 6-5. Memory is allocated in three sections:

1. Instruction Storage Area (ISA).
2. Variable Storage Area (VSA)
3. Free Storage Area (FSA)

The ISA is occupied by the machine code generated by the PL/M source and variables declared in DATA declarations.

The VSA is located above the ISA, and contains (in order of decreasing address):

1. Variables, other than DATA variables, declared in the PL/M source. They are arranged in order of declaration. ADDRESS variables are not aligned.

2. Compiler generated temporaries (i.e., workspace used in the object program, but not explicitly declared).

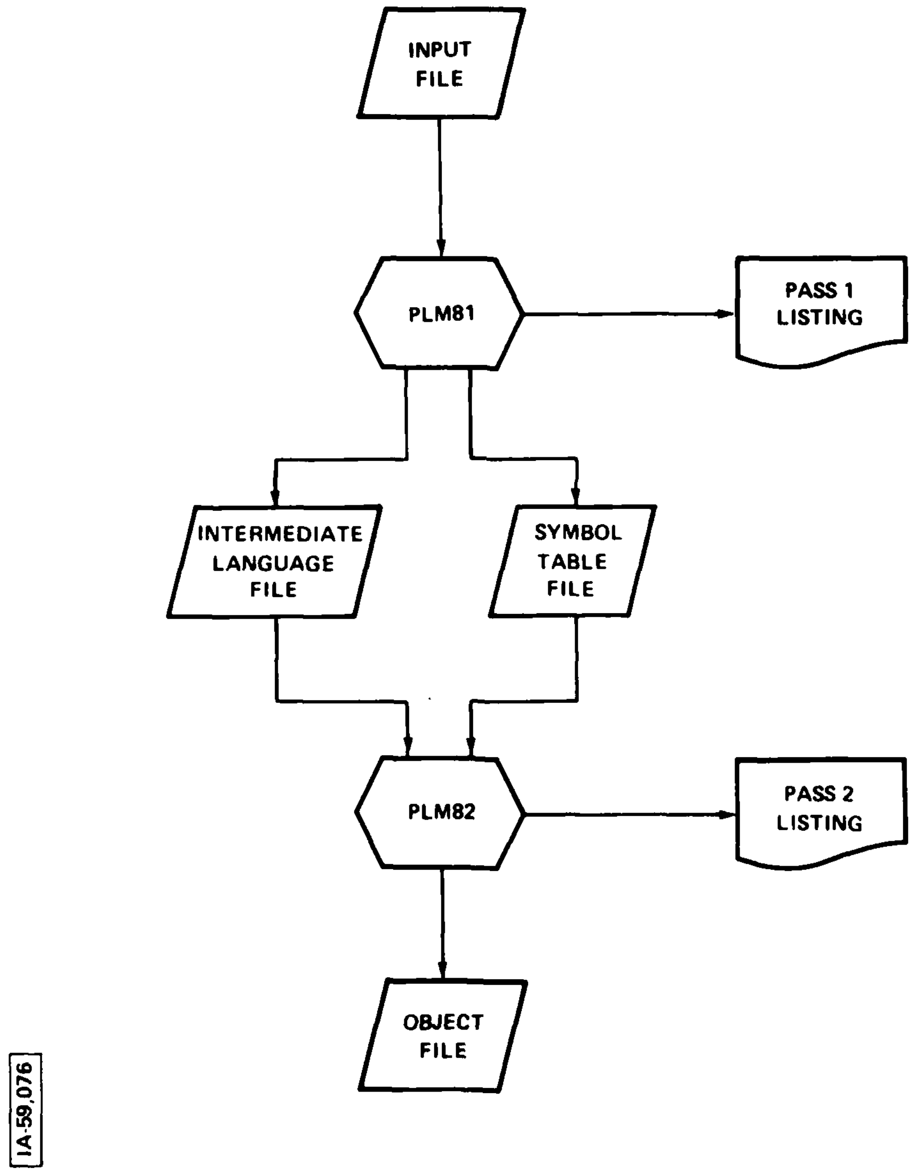


Figure 6-4 File Structure and Flow of Program Execution on 8080 PL/M Cross Compiler

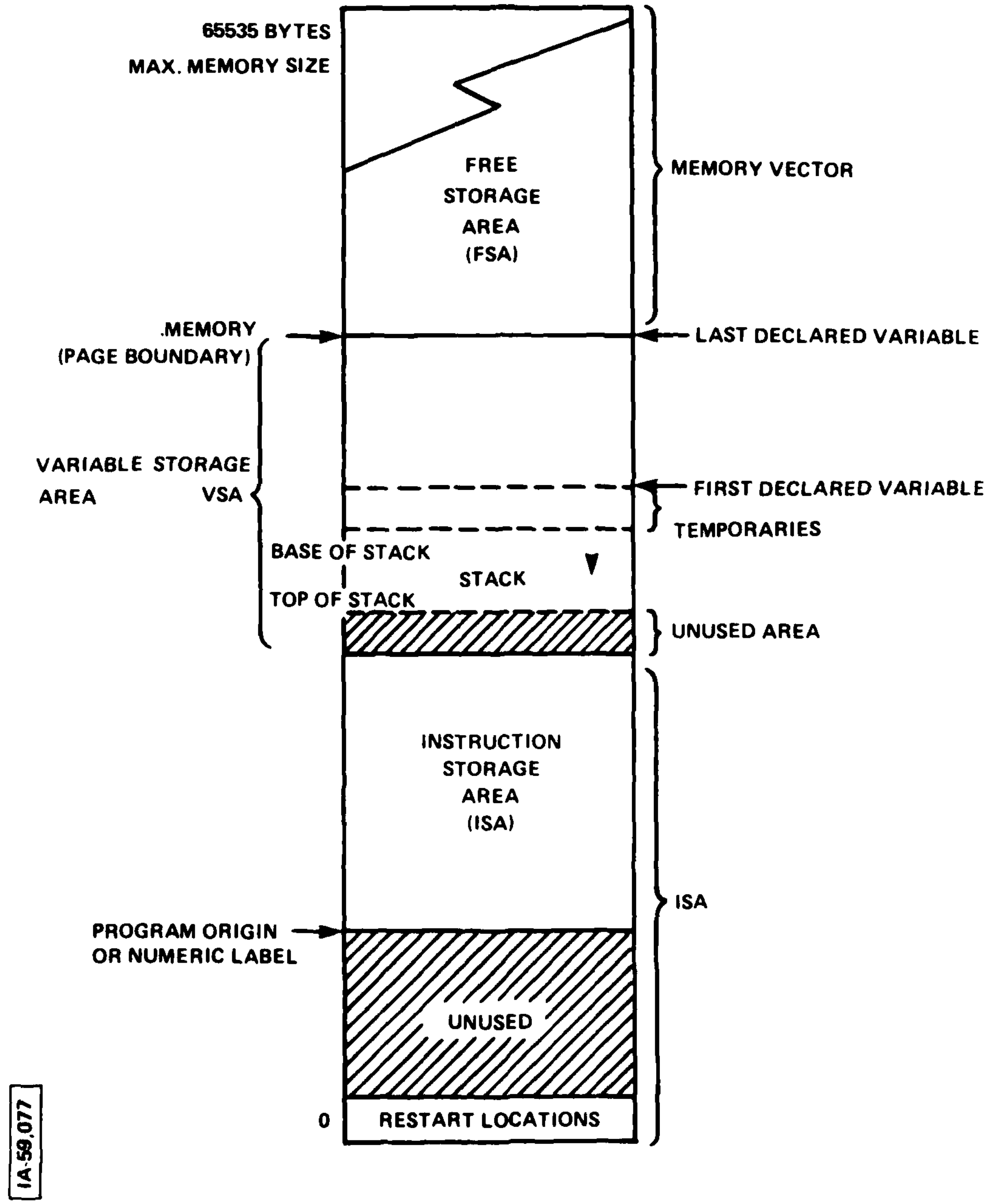


Figure 6-5 Run-Time Storage Organization of Memory Storage Allocation

3. The stack. The size of the stack area is determined by the compiler, unless explicit overrides are used.

The compiler will normally locate the VSA directly above the ISA. However, the compiler user may specify the first page of memory of the VSA explicitly. (A page of memory contains 256 bytes.) This may be used, for example, to ensure that the VSA is located in RAM for a system that has both RAM and ROM.

FSA is the area of memory above the VSA. The PL/M identifier MEMORY may be used to reference the FSA.

6.3.3 INTERP/80 for the 8080 Microprocessor

An INTERP/80 program available on the MITRE TSO system provides a software simulation of the Intel 8080 CPU, along with "free form" execution monitoring commands to aid in system software development for 8080-based microcomputers.

INTERP/80 accepts machine code produced by the PL/M 8080 cross-compiler, along with execution commands from a time-sharing terminal. The execution commands allow manipulation of the simulated system memory and the 8080 CPU registers. In addition, operation and instruction break-points may be set to stop execution at crucial points in the program. Tracing features are available which allow the CPU operation to be monitored. INTERP/80 also provides symbolic reference to memory storage locations as well as numeric reference in various number bases. Some of the commands available in INTERP/80 are presented in table 6-3. For a complete description of INTERP/80, see reference 5.

6.4 TEKTRONIX 8002A SOFTWARE DEVELOPMENT SYSTEM

The heart of the Tektronix software development system is the Tektronix 8002A microprocessor laboratory. The system architecture of the Tektronix 8002A centers around three microprocessors incorporated into circuit card modules. The system processor, using TEKDOS operating system commands, controls system activity such as organizing, storing, and retrieving system and user programs on the disc drives, executing the text and debug programs, supervising the emulator processor through separate debug hardware, and directing all I/O activity for various system peripherals such as the flexible disc unit, the system terminal, and a line printer. See figure 6-6 which shows the 8002A microprocessor laboratory used in conjunction with the Intel SBC 80/20 single board computer.

Table 6-3

INTERP/80 Commands

Command	Function
LOAD	Causes symbol tables and code to be loded into the simulated MCS-80 memory.
GO	Starts execution of the loaded 8080 code.
(NO) INTER	Simulates an 8080 interrupt.
TIME	Sets and displays the simulated 8080 cycle counter.
CYCLE	Allows the simulated CPU to be stopped after a given number of cycles.
(NO) TRACE	Enables tracing feature when particular portions of the program are executed.
(NO) REFER	Causes the CPU simulation to stop when a particular storage location is referenced.
(NO) ALTER	Causes the CPU simulation to stop when the contents of a particular memory location are altered.
CONV	Displays the values of numbers coverted to the various number bases.
DISPLAY	Displays memory locations, CPU registers, symbolic locations, and I/O ports.
SET	Allows the values of memory locations, CPU registers, and I/O ports to be altered.
BASE	Allows the default number base used for output to be changed.
(NO) INPUT	Controls simulated 8080 input ports.
(NO) OUTPUT	Controls simulated 8080 output ports.
PUNCH	Causes output of machine code in BPNF or hexadecimal format.
END	Terminates execution of an 8080 program.

Figure 6-6 Tektronix 8002A Microprocessor Laboratory Workstation

The emulator processor, a system option for each microprocessor the 8002A can support, is controlled by the system processor. Via the debug module hardware, the emulator processor performs two functions. In emulation mode 0, this processor executes the user program so that run-time and logic errors can be detected before actual software/hardware integration begins. In emulation modes 1 and 2, the emulator processor, operating in conjunction with the prototype control probe, provides the capabilities for complete software/hardware debugging and integration. The control probe plugs into the microprocessor socket on the prototype circuit board, thereby enabling the emulator processor to take the place of the actual microprocessor that ultimately is installed in the user hardware. In emulation mode 1, the emulator processor executes the user program under supervision of the debugging system in program memory and memory mapped to the prototype. I/O and clock signals are also available to the user hardware. In emulation mode 2, the emulator processor executes the user program fully in the prototype hardware with all memory, I/O, and clocking functions made available. The debug system, however, still maintains control of the emulator processor.

The third microprocessor, the assembler, runs the relocatable macro assembly program when the TEKDOS assembly command is invoked. Upon completion of assembly, assembled object code is stored on disc memory in hexadecimal format. The assembler performs its function for each separate microprocessor supported by the 8002A with the installation of the appropriate assembler software.

Other circuit card modules within the 8002A provide supporting software and hardware functions. The system memory contains 16K bytes of dynamic RAM and a bootstrap loader resident in 256 bytes of ROM and is accessed only by the system processor. The system memory is automatically loaded with the resident portions of TEKDOS each time the 8002A system is powered up. It also provides buffer space for all I/O activities.

A maximum of 64K bytes of program memory resides on separate circuit-card modules within the 8002A mainframe and can be accessed by the system processor or the emulator processor. Program memory is used by the system processor as a text buffer during text editing sessions and is available during user program execution as a storage area in conjunction with the emulator processor. The feature of separate system/program memory structure allows the system memory to maintain its integrity at all times should the program crash for any reason, thus allowing the operating system software to remain intact.

System components within the 8002A are joined by a common system bus which is divided into a system side and a program side. The debug module provides the hardware interface between the system and emulator processors while the system communications module provides EIA standard RS-232C interfaces for all peripheral devices except the dual flexible disc drive unit and the associated system terminal.

Storage of about 660K bytes on dual disc drives (330K bytes per single-sided disc) is available as the mass storage medium for the 8002A. The drive unit communicates directly with the system processor module through an interconnecting cable.

The real-time trace module, an eight-clip test probe, and the data acquisition interface panel make up the real-time prototype analyzer of the 8002A. The module provides a high-speed buffer memory capable of retaining 128 data words in a dynamic fashion. Each acquired word, composed of 48 bits, contains 16 address bits, eight of 16 bits from the system bus, and eight data bits from the test probe. An additional eight bits identify the type of cycle such as read, write, I/O memory, or instruction fetch. The module also contains the controlling logic circuitry for utilizing the analyzer's command repertoire. The test probe itself is an eight-pin, high-input impedance device which may be connected during emulation modes 1 and 2 to any locations on the user prototype hardware. Fixed TTL or variable threshold levels are switch-selectable on the interface unit, with acquired data buffered by the probe and then fed to the real-time trace module via the cable interface. Data acquired by the trace module and the eight channels of externally acquired data are thus subject to the same TEKDOS command set of the 8002A. Finally, two BNC connectors on the data acquisition interface can also be used to trigger a logic analyzer or scope, thereby allowing greater trouble-shooting capability of prototype circuitry during program execution while maintaining debugging control through the 8002A.

The PROM programmer within the 8002A can support two PROM programming options, one for 1702A PROMs and one for 2704/2708 PROMs. Each option consists of the appropriate plug-in circuit card and PROM programming software to supervise and control the transfer of user programs between program memory and the PROM chip. Interface to the PROM programmer is on the front panel of the 8002A system mainframe, via zero-insertion-force sockets.

The ability of the 8002A to communicate with external host processors provides the flexibility of writing software externally to the 8002A and downloading either source program or source code.

This is particularly useful when high-level language support is separately available, as is the case on the MITRE TSO system.

In summary, the 8002A is a complete design tool for software development to eventual software/hardware integration. Its powerful operating system software, TEKDOS, performs all utility routines, maintains the debugging system, provides emulation support routines, and controls the PROM programmer. The 8002A can support a variety of currently available 8-bit and 16-bit microprocessors and offers full prototype test and emulation capability at three progressive levels.

SECTION 7

CONCLUSIONS/RECOMMENDATIONS

The results of the improved polling project described lead to the following conclusions and recommendations:

- Microcomputer interfacing techniques offer a powerful technique for simulating new AFSATCOM satellite terminal polling performance capabilities.

- This successful microcomputer application was attributable to availability and acquisition (where necessary) of comprehensive computer hardware facilities and high-level language software tools designed to support personnel having little or no background in microprocessor-based techniques. Without these facilities and tools several additional personnel, particularly experienced programmers, would have been required.

- Polling improvements using existing AFSATCOM terminal interfaces via MPU software-only changes appear to offer significant new enhancements to a large segment of the AFSATCOM user community.

- Providing an on-line access to demonstrate these potential capabilities to AFSATCOM users without the need to modify either AFSATCOM hardware or software has proven to be cost-effective. This concept should be pursued in accordance with the follow-on demonstration objectives/plans described below.

- The microcomputer concept and approach described appears to also lend itself to other similar applications. The fully established facilities and proven software support tools for AFSATCOM at MITRE-Bedford should be used in the assessment of future terminal upgrades.

- The feasibility of serially adding microcomputer hardware to an existing AFSATCOM terminal for achieving growth capability has been demonstrated. With further development and suitable qualification of this additional hardware, modifying existing MPU software may be unnecessary.

The microcomputer system as presently configured is capable of operator interface via the RS-232 serial I/O port of its internal SBC 80/10 computer. Using this port, a Texas Instruments Model 765 Intelligent Terminal and a Lear Siegler ADM-3A cathode ray tube

(CRT) terminal were successfully interfaced, both locally and over telephone landlines, using a Bell 103J modem. Thus, a remotable I/O capability has been provided with commercial off-the-shelf hardware. The use of such a remoting capability makes future demonstration testing of polling improvements possible from any location having access to a telephone landline circuit and avoids the need to physically relocate the breadboard microcomputer from its interface at MITRE-Bedford to its collocated AFSATCOM Type 12 CP terminal.

Specific follow-on demonstration and evaluation objectives are derived from key issues related to incorporating polling improvements into the AFSATCOM System. Some of these objectives are:

- Evaluate the operational suitability of improved polling capabilities.
- Evaluate the enhancements resulting from improved polling in relation to performance of the AFSATCOM mission.
- Test and evaluate the effectiveness of the improved polling capabilities, including the operator-terminal interface, in passing message traffic between terminals netted in various polling modes.
- Test and evaluate the adequacy of the microcomputer hardware/software to support the overall objectives.
- Demonstrate the potential role of improved polling capabilities to all concerned agencies, using hands-on hardware/software.
- Develop a successful test-bed for simulating future AFSATCOM hardware/software polling improvements and for investigating other related areas.
- Obtain data and operating experience for an eventual upgrade of the AFSATCOM operations concept.

The improved polling test objectives cited will be fulfilled through three test categories. These are:

- Demonstration of functional interface capabilities
- Terminal performance tests
- Network tests

The first category will show the basic interface capabilities and inherent limitations of the as-designed microcomputer hardware/software in the AFSATCOM environment. The second and third categories will quantify the effectiveness and suitability of the polling improvements at the terminal and network levels and obtain an estimate of actual polled network behavior in an operational environment. This follow-on demonstration can be conducted using the microcomputer hardware/software and the AFSATCOM Type 12 CP terminal located at MITRE-Bedford. This demonstration can be performed jointly by MITRE and Air Force personnel.

LIST OF REFERENCES

1. Intel Systems Data Catalog 1980, Santa Clara, CA: Intel Corporation, August 1979.

2. SBC 80/20 and SBC 80/20-4 Single Board Computer Hardware Reference Manual, Santa Clara, CA: Intel Corporation.

3. 8008 and 8080 PL/M Programming Manual, Rev. A, Santa Clara, CA: Intel Corporation.

4. 8080 PL/M Compiler Operators Manual, Rev. A, Santa Clara, CA: Intel Corporation

5. Intel INTERP/80 User's Manual, Rev A, Santa Clara, CA: Intel Corporation.

APPENDIX A

BASELINE DESCRIPTION OF THE AFSATCOM ROLL CALL POLLING MODE

All Air Force Satellite Communications System (AFSCS) terminals can provide two-way teletypewriter (TTY) record communications using frequency shift keying (FSK) modulation at a 75 bits per second (b/s) serial rate over standard ultra high frequency (UHF) channels. The Roll Call Polling mode is one of four modes possible on the narrow-band FSK channels; the other modes are Random, TDM-1, and TDM-2.

A.1 ROLL CALL POLLING SYSTEM

Polling may be conducted on either half-duplex or full-duplex circuits and requires both a Net Control Station (NCS) and network discipline. The NCS transmits Poll Call messages to each pollable automatic send/receive (ASR) unit in the network. Each ASR, when polled, is given a 30-second period of time in which to transmit a precomposed response to the NCS. When individual ASRs are in the poll mode, they are inhibited from transmitting unless they are polled.

Roll Call Polling is initiated by a command post (CP) terminal. Force terminals reply through use of a stored message buffer in the ASR containing the previously prepared response. Poll inquiry is then possible when the polling function is selected at the ASR device.

When the CP message-processor generated poll inquiry is detected at the polled terminal through use of a unique code sequence peculiar only to that particular terminal or ASR, the precomposed message is transmitted back to the CP terminal. Roll Call Polling is structured so that the CP NCS queries each terminal in the polling net in sequence and each polled terminal replies only upon detection of its own unique code.

The Roll Call message from the CP NCS is unclassified and structured as shown in table A-1 and table A-2.

Table A-1

Roll Call Message Format

$$\text{UUU}, \underbrace{\overline{\text{SOH}}, \text{N}, \underbrace{A_1, A_2, A_3}_{\text{Address Characters*}}}_{\text{Address Header}}, \overline{\text{ETX}}$$

where N = variable mode character**

* A_3 designates the particular super group.

A_2 and A_3 designate the particular group.

A_1 and A_2 and A_3 designate the particular member.

** The mode character found in the message address header is signified by the variable N representing address header codes.

Selective Inquiry message structure is closely related to Poll Call message structure and differs only by the change to the variable found in the mode character.

The address portion of Selective Inquiry messages is similar to the Poll Call message and consists of an SOH character denoting start-of-header and signifying that the next four characters are an address header. The first character following the SOH is the mode character whose codes are represented in table A-2. It should be noted that only when the mode character is 0 does it denote that the message is a Poll Call.

Table A-2

Address Header Codes

N = Mode	Function	
0	Poll Call	
1	Super Group Call	
2	Group Call	Selective Inquiry Modes
3	Individual Call	

An All Call mode, denoted by no address header, is accomplished by omission of the SOH designator, the mode character, and the three address designation characters.

The three address designator characters (second, third, and fourth characters following the SOH) use three hexadecimal digits (0-9, A-F) for A_1, A_2, and A_3 and result in 4096 possible addresses.

Each pollable device in the network must have a unique programmed address. This address is manually inserted into the ASR via thumbwheels and must be part of the Poll Call message. If there is a match, the precomposed message will be transmitted as a Poll Response message with an unclassified message structure, as follows:

UUU, $\overline{SOH}$, F, A_1, A_2, A_3, message (if any), $\overline{ETX}$,

where F is the mode character indicating that the message is a Poll Response.

If there is no match, the Poll Response message is not transmitted.

A.2 CP TERMINAL POLLING

The message processor unit (MPU) within the CP terminal can accommodate four poll groups, with each group containing up to 16 members for a total of 64 members. Members of any one group are restricted to the same combination of second and third (A_2 and A_3) address characters. Two polling commands are defined. One command causes all members of a single group to be polled. The other command causes all members of all groups currently defined to be polled.

Upon reception of a polling communications supervisory (COMSUP) command from an ASR, the MPU transmits a poll request message sequentially to each member of the group, waiting 30 seconds between requests for replies. A poll response is timed out if not received in its entirety within 30 seconds. The MPU will automatically change the individual address character (A_1) designating a member of a group with each successive poll request message according to the stored poll table in the MPU. This poll table can be either entered or changed by COMSUP commands, which provide for the dynamic definition and maintenance of up to four concurrent poll groups. New groups can be added, existing groups deleted, or individual members added or deleted from existing groups. See table A-3 for a listing of COMSUP commands applicable to polling.

Table A-3

COMSUP Commands Used in Polling Operations

COMSUP Command		Description
1) $\overline{\text{P}}$ATG gg $\left[\text{ll} \left\| \text{a} \right\| \text{..}\right]$ $\overline{\text{c}}$		ADD TO/CREATE POLL GROUP
	gg =	2-character group identifier where all alphabetic characters are upper case. Characters for "gg" must be selected from the hexadecimal group Ø through 9, A through F.
	ll =	Optional 2-character line mnemonic to poll on; the line mnemonic is specified only when defining a new group.
	a =	Aircraft identifier (one to eight characters may be specified in one command). All alphabetic characters are upper case. Characters "a" must be selected from the hexadecimal group Ø through 9, A through F.
2) $\overline{\text{P}}$DEL gg $\left[\left\| \text{a} \right\| \text{..}\right]$ $\overline{\text{c}}$		DELETE FROM POLL GROUP
	gg =	2-character group identifier where all alphabetic characters are upper case.
	a =	Aircraft identifier (one to eight characters may be specified). If none is specified, the entire group will be deleted. All alphabetic characters are upper case. Characters for "a" must be selected from the hexadecimal group Ø through 9, A through 9.
3) $\overline{\text{P}}$PLG gg $\overline{\text{c}}$		POLL GROUP
	gg =	2-character group identifier where all alphabetic characters are upper case.
4) $\overline{\text{P}}$PAG $\overline{\text{c}}$		POLL ALL GROUPS

Table A-3 (Continued)

Notes

The group tables are built and maintained dynamically in response to operator commands. A new group will be defined as a result of an ATG command that calls out a group not already in the tables. Members in a group are identified in the ATG and DEL commands by three characters; the last two characters of a group member identifier are the same as the group identifier. When all group tables are in use, the form of the command used for defining up to four groups at any given time will be rejected by the MPU. Another form of the command is available for use in subsequently adding additional members to an existing group. Attempts to add a member already in the group will cause the entire command to be rejected.

For the command used to delete individual members from a polling group, the entire command is processed and all identifiers are validated by the MPU before the group table entry is modified. Any error detected will cause the entire group to be rejected. Another form of this deletion command is available for use in deleting an entire group and releasing the associated table entry. It should be noted that the first form of this command can also result in the group table entry being released if all its members are released.

Each member is polled by building a Poll Call message containing the group and member identifiers, then queuing the message to the MPU output line associated with the group.

When the Poll Response message is received, it is verified and forwarded to a high speed printer with the prefix POLL RESPONSE RX. The next group is then polled and the process continues until the entire group has been polled. If no response is received from a particular member within 30 seconds, a print-out alarm is generated to indentify the group member who failed to respond. A received response from a terminal not polled (e.g., address of responding terminal does not match that in the poll request message) results in the message being intercepted, forwarded for printout on the high speed printer, and a POLL RESPONSE ER interrupt message being printed out along with the Poll Response. See table A-4 for a description of the MPU Status/Alarm and Intercept Messages for polling.

Table A-4

MPU Status/Alarm and Intercept Messages

Condition	Status/Alarm Message
1) GROUP XX POLL COMPLETE XX 2 hexadecimal digits, a group identifier.	PLG XX COM
2) ALL GROUP POLL COMPLETE Processor has completed polling all previously defined groups.	PAG COM
3) NO RESPONSE TO POLL A time-out has occurred on a particular member.	POLL RSP T/O
Reason for Intercept	**Intercept Message**
4) Poll Response from station not polled	POLL RESPONSE EP
5) Poll Response received	POLL RESPONSE RX

Note:

MPU-generated Status/Alarm messages are prefixed with a date-time header and a line identification mnemonic which indicates the source of the message.

A.3 FORCE TERMINAL POLLING

As a member of a poll, the Force terminal pollee must dial his proper address into the ASR thumbwheels, enable the address recognition switch on the ASR, and press the poll XMT button once. Whenever the ASR receives a message header of the format following the UUU consisting of:

$\underline{SOH}$, Ø, A_1, A_2, A_3

where

A_1, A_2, A_3 is the ASR address,

the ASR will automatically transmit whatever is in ASR storage up to the message length selected, each time the ASR is polled. If a change to the Poll Response message is desired, the operator must press the compose and edit button and make the changes, thereby taking the particular ASR out of the automatic poll response mode. Thus, poll responses are inhibited while the Poll Response messages are either updated or revised. After update, the poll XMT button must be depressed again to return to the poll. Both Poll Call and Poll Response messages should print out on the pollee's ASR. In addition, any text attached to the Poll Call message will not be printed out by the pollee's ASR, regardless of model ASR (i.e., 120A; 120B; 129; Mini-I/O). In actual operation during an automatic poll request, the model 120A ASR prints nothing; models 120B, 129, and the Mini-I/O print only the poll message (five characters described above) along with the ETX (whenever it occurs).

A.4 OTHER MPU-EQUIPPED TERMINAL POLLING

An MPU-equipped terminal can also be polled as described above but is limited to a shorter Poll Response message because of the message transfer technique inherent in the MPU-equipped terminal. Since data are transferred from the modem to ASR on a message-by-message basis, the complete Poll Response message is transferred into the processor from the ASR before going to the modem. To stay within the CP processor poll-out time of 30 seconds, the maximum length of a Poll Response message from a processor equipped terminal is 130 characters.

APPENDIX B

PL/M-80 SOURCE CODE

```
/*   III.DATA - MOD 2: VERSION 1  - 10 JULY 80          */
/*   HHH.DATA -  MOD 1: VERSION 3   -   10 JAN. 80     */
/**/
/*         IMPROVED POLLING COMSUP COMMANDS               */
/*    ENABLE CHECKIN MODE                    ZNR!SABC1XXX    */
/*    DISABLE CHECKIN MODE                   ZNR!SABC0XXX    */
/*    PCI TABLE CHECKIN                      ZNR!CABCAAA1    */
/*    RCI TABLE CHECKIN                      ZNR!DABCBBB1    */
/*    NCI TABLE CHECKIN                      ZNR!EABCCCC0    */
/*    GCI TABLE CHECKIN                      ZNR!BABCDD1     */
/*    PRIORITY TABLE LOAD                    ZNR!1ABC....    */
/*    ROUTINE TABLE LOAD                     ZNR!2ABC....    */
/*    NO-TRAFFIC TABLE LOAD                  ZNR!3ABC....    */
/*    DISABLE COMSUP MSG PRINTOUT            ZNR!4ABC0       */
/*    ENABLE COMSUP MSG PRINTOUT             ZNR!4ABC1       */
/*    RE-INITIALIZE PCI TABLE                ZNR!FABC        */
/*    RE-INITIALIZE RCI TABLE                ZNR!GABC        */
/*    RE-INITIALIZE NCI TABLE                ZNR!HABC        */
/*    RE-INITIALIZE GCI TABLE                ZNR!AABC        */
/*    PRIORITY CHECKIN TABLE TRANSFER        ZNR!TABCXXYZ    */
/*    ROUTINE CHECKIN TABLE TRANSFER         ZNR!TABCYXYZ    */
/*    NO-TRAFFIC CHECKIN TABLE TRANSFER      ZNR!TABCZXYZ    */
/*    POLL TABLE TRANSFER                    ZNR!TABCTXYZ    */
/*    BUILD & PRINTOUT POLL TABLE            ZNR!MABC        */
/*    POLL TABLE PRINTOUT (LOCAL ONLY)       ZNR!UABCZXYZL   */
/*    POLL TABLE PRINTOUT (REMOTE ALL-CALL)  ZNR!UABCZXYZR   */
/*    PRIORITY TABLE PRINTOUT                ZNR!UABCPXYZ    */
/*    ROUTINE TABLE PRINTOUT                 ZNR!UABCRXYZ    */
/*    NO-TRAFFIC TABLE PRINTOUT              ZNR!UABCQXYZ    */
/*    GROUP TABLE PRINTOUT                   ZNR!UABCOXYZ    */
/*    POLL ENABLE (SINGLE POLL)              ZNR!JABC1S      */
/*    POLL ENABLE (MULTIPLE POLL)            ZNR!JABC1M      */
/*    POLL DISABLE (SINGLE)                  ZNR!JABC0S      */
/*    POLL INTERRUPT ENABLE (NON-TDM)        ZNR!LABC10      */
/*    POLL INTERRUPT ENABLE (TDM)            ZNR!LABC01      */
/*    POLL INTERRUPT ENABLE (TDM & NON-TDM)  ZNR!LABC11      */
/*    POLL INTERRUPT DISABLE (TDM & NON-TDM) ZNR!LABC00      */
/*    PRIORITY CHECKIN TABLE DELETION        ZNR!NABCP01     */
/*    ROUTINE CHECKIN TABLE DELETION         ZNR!NABCR01     */
/*    NO-TRAFFIC CHECKIN TABLE DELETION      ZNR!NABCN01     */
/*    GROUP CHECKIN TABLE DELETION           ZNR!NABCG01     */
/* FEEDBACK & POLL SLOT REASSIGNMENT         ZNR!OABC.........      */
/*    EDAC ENABLE (NON-TDM)                  ZNR!PABC1       */
/*    EDAC DISABLE (NON-TDM)                 ZNR!PABC0       */
/*    MESSAGE TRANSMISSION DELAY (NON-TDM)   ZNR!KABC10      */
/*    ENABLE ALL TYPES OF MESSAGES           ZNR!VABC0       */
/*    DISREGARD NON-COMSUP MSGS WHEN POLLING ZNR!VABC1    */
/*    DISREGARD ALL NON-COMSUP MESSAGES      ZNR!VABC2    */
/*    PROGRAM RESTART (RE-IPL MICROPROCESSOR) ZNR!RABC    */
/*    RS232 INTERFACE ENABLE(1)/DISABLE(0)   ZNR!QABC1    */
/*    MICROPROCESSOR ADDRESS CHANGE          ZNR!IABCCAB  */
/**/
/**/
/*           NOTES        */
/*  1) ALL COMSUP MSGS REQUIRE "ZNR!" FOLLOWED BY AT LEAST      */
/*     ONE MODE CHARACTER IMMEDIATELY AFTER THE "!" .           */
/*  2) TWO ETX'S ARE PART OF THE COMSUP MSG SUFFIX .            */
/*  3) "XYZ" IS INDICATIVE OF A HEXIDECIMAL DESTINATION ADDRESS */
/*  4) "ABC" IS INDICATIVE OF THE INITIALIZED ADDRESS OF THE    */
/*     MICROPROCESSOR; THIS IS A COMSUP VARIABLE IN ITSELF.     */
/**/
/**/
/*   INPUT-/ OUTPUT DESCRIPTIONS   */
```

```
/*          INPUT 1 = CHAR READY FROM MODEM         */
/*          INPUT 101 = CHAR READY FROM MPU         */
/*          INPUT 2 = CONTINUE PROGRAM              */
/*          INPUT 3 = CHAR FROM MODEM               */
/*          INPUT 103 =  CHAR FROM MPU               */
/*          INPUT 5 = SPACE FOR OUTPUT TO MPU     */
/*          INPUT 105 = SPACE FOR OUTPUT TO MODEM */
/*          INPUT <7>: 230 (E6H) = CLOCK FOR MICROPROCESSOR     */
/*          INPUT <107>: 229 (E5H) = CLOCK FROM MODEM         */
/*          INPUT <9>: 228 (E4H) = BCD SLOT INPUTS            */
/*                                          */
/**/
/*                 8253 PROGRAMMABLE COUNTER INPUT/OUTPUT        */
/*     OUTPUT 220 (DCH) = LOAD/READ COUNTER NO. 0 (8253)         */
/*          OUTPUT 222 (DEH) = LOAD/READ COUNTER NO. 2 (8253)    */
/*          OUTPUT 223 (DFH) = WRITE MODE WORD/NO-OP(3-STATE)    */
/**/
/*          OUTPUT 1 = DATA TO MPU                  */
/*          OUTPUT 101 = DATA TO MODEM              */
/*        OUTPUT 2 = DIAGNOSTICS              */
/*          OUTPUT <4>: 233 (E9H) = PARITY DISABLE TO MODEM   */
/*                                 AND I/O CHIP RESET         */
/*          OUTPUT <8>: 234 (EAH) = RX ENABLE TO MPU          */
/*          OUTPUT <108>: 235 (EBH) = I/O TX ENABLE TO MODEM        */
/*                               AND RX CLOCK ENABLE TO MPU        */
/**/
/*                RS232  INPUT/OUTPUT                               */
/*          OUTPUT 237 (EDH) = CONTROL WORD (CPU TO USART)          */
/*          OUTPUT 236 (ECH) = DATA (CPU TO USART)                  */
/*          INPUT 237 (EDH) = STATUS WORD (USART TO CPU)            */
/*          INPUT 236 (ECH) = DATA (USART TO CPU)                   */
/**/
/**/
/**/
/*          MEMORY ADDRESSES FOR I/O              */
/**/
/*              INPUT1$ADR = OFFC0H               */
/*              INPUT3$ADR = OFF40H               */
/*              OUTPUT1$ADR = OFE40H              */
/*              INPUT101$ADR = OFEC0H             */
/*              INPUT103$ADR = OFE4CH             */
/*              INPUT105$ADR = OFF00H             */
/*              OUTPUT101$ADR = OFF40H            */
/*              INPUT5$ADR = OFE00H               */
/**/
/**/
/**/
/**/
DECLARE (PROGRAM$START, INITIAL$MSG) LABEL;
/*  RS232 I/O CHIP INITIALIZATION */
         /* MODE CONTROL */
PROGRAM$START: OUTPUT(237) = 79H;
/*  79H = 0111 1001B; 01=1 STOP BIT/1=EVEN PARITY/1=PARITY ENABLE */
/*                   10=7 BIT CHARACTER/01=1X BAUD RATE FACTOR */
         /* COMMAND INSTRUCTION - RESET */
         OUTPUT(237) = 40H;
         /* MODE INSTRUCTION */
         OUTPUT(237) = 79H;
         /* COMMAND INSTRUCTION - INITIALIZATION  */
         OUTPUT(237) = 17H;
/*    17H = 0001 0111B; 0=ENTER HUNT MODE/0=INTERNAL RESET/      */
/*        0=RTS/1=ERROR RESET/0=SEND BREAK CHAR/1=RX ENABLE  */
/*         1=DTR(NOT) OUTPUT FORCED TO ZERO/1=TX ENABLE      */
```

```
/**/
/*   CONTROL WORD INITIALIZATION (8255 # 1 CONTROL ONLY)     */
          OUTPUT(231) = 9BH;
          OUTPUT(235) = 90H;
          OUTPUT(233) = 10H;
          OUTPUT(233) = 0H;
          OUTPUT(233) = 10H;
/**/
/*   CONTROL REGISTER INITIALIZATION          */
DECLARE MPU$IO$CTL1$POINTER ADDRESS INITIAL (0FF00H);
DECLARE MPU$IO$CTL1 BASED MPU$IO$CTL1$POINTER BYTE;
          MPU$IO$CTL1$POINTER = 0FF00H;
          MPU$IO$CTL1 = 03H XOR 0FFH;
/**/
DECLARE MPU$IO$CTL2$POINTER ADDRESS INITIAL (0FF40H);
DECLARE MPU$IO$CTL2 BASED MPU$IO$CTL2$POINTER BYTE;
          MPU$IO$CTL2$POINTER = 0FF40H;
          MPU$IO$CTL2 = 2FH XOR 0FFH;
/**/
          MPU$IO$CTL1 = 43H XOR 0FFH;
          MPU$IO$CTL2 = 03H XOR 0FFH;
          MPU$IO$CTL1 = 0C0H XOR 0FFH;
/**/
/**/
DECLARE MODEM$IO$CTL1$POINTER ADDRESS INITIAL (0FE00H);
DECLARE MODEM$IO$CTL1 BASED MODEM$IO$CTL1$POINTER BYTE;
          MODEM$IO$CTL1$POINTER = 0FE00H;
          MODEM$IO$CTL1 = 03H XOR 0FFH;
/**/
DECLARE MODEM$IO$CTL2$POINTER ADDRESS INITIAL (0FE40H);
DECLARE MODEM$IO$CTL2 BASED MODEM$IO$CTL2$POINTER BYTE;
          MODEM$IO$CTL2$POINTER = 0FE40H;
          MODEM$IO$CTL2 = 2FH XOR 0FFH;
/**/
          MODEM$IO$CTL1 = 43H XOR 0FFH;
          MODEM$IO$CTL2 = 03H XOR 0FFH;
          MODEM$IO$CTL1 = 0C0H XOR 0FFH;
/**/
/**/
/* INSTRUCTION FOR DIVIDE BY 1240 (300 HZ) ON 16-BIT COUNTER # 2  */
          OUTPUT(223) = 0B6H;
          OUTPUT(222) = 0D8H;
          OUTPUT(222) = 04H;
/*  INSTRUCTION FOR DIVIDE BY 4962 (75 HZ) ON COUNTER # 0    */
     OUTPUT(223) = 36H;
     OUTPUT(220) = 62H;
     OUTPUT(220) = 13H;
/* THESE GIVE 75 & 300 HZ CLOCKS FROM 6.70 MHZ ON-BOARD XTAL */
/**/
/**/
DECLARE  RS232$FLAG BYTE INITIAL(0);
            RS232$FLAG = 0;
DECLARE (RS232$SPACE$TEST, RS232$OUTCHAR, RS232$INPUT1,
            RS232$GC1, RS232$MODE$SET) LABEL;
DECLARE (ADR1, ADR2, ADR3 ) BYTE INITIAL ('A','B','C');
          ADR1 = 'A';
          ADR2 = 'B';
          ADR3 = 'C';
DECLARE(POLL$SLOT1H, POLL$SLOT2H, POLL$SLOT3H, POLL$SLOT4H,
   POLL$SLOT5H, POLL$SLOT6H, POLL$SLOT1L, POLL$SLOT2L, POLL$SLOT3L,
   POLL$SLOT4L, POLL$SLOT5L, POLL$SLOT6L, TX$SLOT$INITIALH,
   TX$SLOT$INITIALL, TDM$POLL$TX$SLOT$INITIAL) BYTE
     INITIAL('1','1','2','3','4','5','1','9','7','5','3','1','0','1',1);
```

```
        POLL$SLOT1H = '1';
        POLL$SLOT1L = '1';
        POLL$SLOT2H = '1';
        POLL$SLOT2L = '9';
        POLL$SLOT3H = '2';
        POLL$SLOT3L = '7';
        POLL$SLOT4H = '3';
        POLL$SLOT4L = '5';
        POLL$SLOT5H = '4';
        POLL$SLOT5L = '3';
        POLL$SLOT6H = '5';
        POLL$SLOT6L = '1';
        TX$SLOT$INITIALH = '0';
        TX$SLOT$INITIALL = '1';
        TDM$POLL$TX$SLOT$INITIAL = 4;
DECLARE (CS3, CS4) BYTE;
DECLARE (POLL$XMIT, POLL$MODE$ERROR, POLL$OVER$TEST, XX, YY, WW, ZZ,
     REPOLL$TEST, POLL$MSG$COMPLETE, OUTTABLE1$STATUS$TEST,
     POLLING$MODE$TEST, AUTO$POLL$RESTART, NON$TDM$POLL, EDAC$MODE$SET,
     TDM$POLL, POLL$TABLE$TX, POLL$INTERRUPT,RETRANSMIT$FLAG$SET) LABEL;
DECLARE POLL$MSG$COUNT ADDRESS INITIAL(0);
          POLL$MSG$COUNT = 0;
DECLARE NTDM$EDAC$TABLE(7) BYTE;
DECLARE (EDAC$FLAG, REPOLL$FLAG$COUNT) BYTE INITIAL (0,0);
          EDAC$FLAG = 0;
          REPOLL$FLAG$COUNT = 0;
DECLARE (CC2$PRESENT, CC1$PRESENT) ADDRESS INITIAL (0,0);
        CC2$PRESENT = 0;
        CC1$PRESENT = 0;
DECLARE ( IPOLL101, GC1, OPOLL101, IPOLL1011, NON$TDM$DELAY1, POLL$MODE,
     DELAY$ROUTINE1, EAT$MSG$SET, MODEM$OUTPUT$COMPOSE1,
LCT1, OUTFLAG1, ECMTEST1, SPACETEST1,  NON$TDM$DELAY$SET, CHAR4T1,
COMSUPLOAD1, OUTCHAR1, NOCOMSUPLOAD1 , RX$BUSY$OVERRIDE1,IPOLL11) LABEL;
DECLARE ( SHIFTDOWN, SHIFTDOWN1, LOADADR, ENDLOAD, ADRERROR1 ) LABEL ;
DECLARE EAT$MSG$FLAG1 BYTE INITIAL(01H);
     EAT$MSG$FLAG1 = 01H;
DECLARE (CLK1, CLKP1,  DELAY1, CLK2, CLKP2,  CLK3,
  CLKP3 ) BYTE INITIAL (0,0,0,0,0,0,0);
DECLARE (CLKCNT1, CLKCNT2, CLKCNT3) ADDRESS INITIAL (0,0,0);
          CLK1 = 0;
          CLKP1 = 0;
          CLKCNT1 = 0;
          DELAY1 = 0;
          CLK2 = 0;
          CLKP2 = 0;
          CLKCNT2 = 0;
          CLK3 = 0;
          CLKP3 = 0;
          CLKCNT3 = 0;
DECLARE (BUFFER$DELAY1, NON$TDM$MSG$DELAY1) ADDRESS INITIAL (48,300H);
          BUFFER$DELAY1 = 48;
          NON$TDM$MSG$DELAY1 = 300H;
DECLARE (EDAC$ROUTINE,OUTPUT$COMPOSE,PTT$LOAD1,DELAY$CAL,
   NTT$LCAL1,  NTT$LOAD1, TT$LCAL$END1) LABEL;
DECLARE ( TCLK, TCLKP, TCLKCNT) BYTE INITIAL(0,0,0);
          TCLK = 0;
          TCLKP = 0;
          TCLKCNT = 0;
DECLARE (MSG$OVER$DELAY, TCLK1, TCLKP1, TCLKCNT1) BYTE
        INITIAL(64, 0, 0, 0);
          MSG$OVER$DELAY = 60H;
          TCLK1 = 0;
          TCLKP1 = 0;
```

```
            TCLKCNT1 = 0;
DECLARE (RETRANSMIT$FLAG, TDM$POLL$TX$SLOT) BYTE INITIAL(0,1);
            RETRANSMIT$FLAG = 0;
            TDM$POLL$TX$SLOT = 1;
DECLARE (SLOTH,SLOTL,SLOT,SLOT$COUNT) BYTE INITIAL (0,0,0,0);
            SLOTH = 0;
            SLOTL = 0;
            SLOT = 0;
            SLOT$COUNT = 0;
DECLARE (NTDMDELAYH, NTDMDELAYL) ADDRESS INITIAL(0,0);
            NTDMDELAYH = 0;
            NTDMDELAYL = 0;
DECLARE SLOT$GUARD$TIME ADDRESS INITIAL(20H);
            SLOT$GUARD$TIME = 20H;
DECLARE (TDM$FLAG, POLL$FLAG, AUTO$REPOLL$FLAG) BYTE INITIAL('0', 0, 0);
            TDM$FLAG = '0';
            POLL$FLAG = 0;
            AUTO$REPOLL$FLAG = 0;
DECLARE (POLL$TABLE$TX$FLAG, NTDM$POLL$INTERRUPT$FLAG,
   TDM$POLL$INTERRUPT$FLAG) BYTE INITIAL(0,0,0) ;
            POLL$TABLE$TX$FLAG = 0;
            NTDM$POLL$INTERRUPT$FLAG = 0;
            TDM$POLL$INTERRUPT$FLAG = 0;
DECLARE ( CS1,   CHAR1, OUT1,
  WAITING1,  SPACE1, LINECOUNT) BYTE;
            OUT1 = 0;
            WAITING1 = 0;
DECLARE CHARSTORE1(2000) BYTE;
DECLARE MSGCOUNT1(150) ADDRESS;
DECLARE OUTTABLE1 (2000) BYTE;
DECLARE ( I1, TC1, OUTCOUNT1,CC1,J) ADDRESS INITIAL (0,0,1,0,0);
            J = 0;
            I1 = 0;
            TC1 = 0;
            OUTCOUNT1 = 1;
            CC1 = 0;
DECLARE CS$DATA$POINTER ADDRESS INITIAL(0FF00H);
DECLARE CS$DATA BASED CS$DATA$POINTER BYTE;
            CS$DATA$POINTER = 0FF00H;
DECLARE INPUT3$DATA$POINTER ADDRESS INITIAL (0FF40H);
DECLARE INPUT3$DATA BASED INPUT3$DATA$POINTER BYTE;
            INPUT3$DATA$POINTER = 0FF40H;
DECLARE INPUT5$DATA$POINTER ADDRESS INITIAL (0FE00H);
DECLARE INPUT5$DATA BASED INPUT5$DATA$POINTER BYTE;
            INPUT5$DATA$POINTER = 0FE00H;
DECLARE OUTPUT1$DATA$POINTER ADDRESS INITIAL (0FE40H);
DECLARE OUTPUT1$DATA BASED OUTPUT1$DATA$POINTER BYTE;
            OUTPUT1$DATA$POINTER = 0FE40H;
DECLARE CS1$DATA$POINTER ADDRESS INITIAL (0FE00H);
DECLARE CS1$DATA BASED CS1$DATA$POINTER BYTE;
            CS1$DATA$POINTER = 0FE00H;
DECLARE INPUT103$DATA$POINTER ADDRESS INITIAL (0FE40H);
DECLARE INPUT103$DATA BASED INPUT103$DATA$POINTER BYTE;
            INPUT103$DATA$POINTER = 0FE40H;
DECLARE INPUT105$DATA$POINTER ADDRESS INITIAL (0FF00H);
DECLARE INPUT105$DATA BASED INPUT105$DATA$POINTER BYTE;
            INPUT105$DATA$POINTER = 0FF00H;
DECLARE OUTPUT101$DATA$POINTER ADDRESS INITIAL (0FF40H);
DECLARE OUTPUT101$DATA BASED OUTPUT101$DATA$POINTER BYTE;
            OUTPUT101$DATA$POINTER = 0FF40H;
/**/
/**/
DECLARE (CS,CHAR,ENC,MOF,MODE,
```

AD-A102 294 MITRE CORP BEDFORD MA F/G 17/2.1
MICROCOMPUTER POLLING IMPROVEMENTS FOR AFSATCOM.(U)
JUN 81 J HANDWERKER F19628-81-C-0001
UNCLASSIFIED MTR-8239 ESD-TR-81-118 NL

2 of 2
AD
A102294

END
DATE
FILMED
8-81
DTIC

```
          WAITING, SPACE) BYTE;
           ENC = 0;
           MJF = 0;
           WAITING = 0;
DECLARE (N, NUM$GCI, TOTAL$NUM$CI,
    NUM$PCI, PCI$POINTER, NC,  NUM$RCI, RCI$POINTER, GCI$POINTER,
NUM$NCI, NCI$POINTER,  CLKCNT, TCINITIAL, TC1INITIAL) ADDRESS;
           TOTAL$NUM$CI = 0;
           NUM$GCI = 0;
           NUM$PCI = 0;
           NUM$RCI = 0;
           NUM$NCI = 0;
           CLKCNT = 0;
           TCINITIAL = 0;
           TC1INITIAL = 0;
DECLARE (CLK, CLKF, DELAY) BYTE INITIAL(0,0,0);
           CLK = 0;
           CLKF = 0;
           DELAY = 0;
DECLARE (BUFFER$DELAY, MSG$DELAY ) ADDRESS INITIAL(48, 640);
           BUFFER$DELAY = 48;
           MSG$DELAY = 160;
DECLARE ( IPOLL1, GC, OPOLL1, QUIT, ST, MJT1, LCT, CHAR3T,
    CHAR4T, CHAR5T, CS$TEST, PRB$LOAD, RRB$LOAD, NRB$LOAD, MJT2,
     PTT$LOAD$END, RTT$LOAD$END, NTT$LOAD$END,
    PTT$LOAD, RTT$LOAD, NTT$LOAD, OUT$TABLE$BUILD, C$MODE$CANCEL1,
    PCI$TEST, CC$TEST, RCI$TEST, NCI$TEST, CI$NUM$TEST, C$MODE$CANCEL,
    LOM$TEST, SPACE$TEST,  DELAY$ROUTINE, OUT$CHAR ) LABEL;
DECLARE (PCIRESET, RCIRESET, NCIRESET, GCIRESET, ADRCHANGE ) LABEL;
DECLARE ( STAR$INSERT, MPU$TABLE$BUILD ) LABEL ;
DECLARE ( PCISTORE, RCISTORE, NCISTORE ) (385) BYTE;
DECLARE GCISTORE(321) BYTE;
DECLARE CHAR$STORE(2000) BYTE;
DECLARE MSG$COUNT(150) ADDRESS;
   DO I1 = 0 TO 149;
       MSGCOUNT(I1) = 0;
   END;
DECLARE (ENCRYPT, ENCTEST ) LABEL;
DECLARE SOH LITERALLY '01H' ;
DECLARE C$MODE BYTE INITIAL (0H) ;
           C$MODE = 0H;
DECLARE PCI$HEADER DATA ('*PRIORITY*CI:') ;
DECLARE (I,TC,OUT$COUNT, CC) ADDRESS INITIAL (0,0,1,0);
           I = 0;
           TC = 0;
           OUT$COUNT = 1;
           CC = 0;
DECLARE RCI$HEADER DATA ('RCI:') ;
DECLARE OUT$TABLE(2000) BYTE;
DECLARE NCI$HEADER DATA ('NCI:') ;
DECLARE PRB$HEADER DATA ('*PRIORITY*RB') ;
DECLARE RRB$HEADER DATA ('RRB:') ;
DECLARE NRB$HEADER DATA ('NRB:') ;
DECLARE PTT$HEADER DATA ('*PRIORITY*TT');
DECLARE RTT$HEADER DATA ('RTT:') ;
DECLARE NTT$HEADER DATA ('NTT:') ;
/*   */
DECLARE ( COMPOSE1, PT1, RT1, NT1, GT1, POLLTABLEBUILD1, IPL$TEST,
  CHECKINMODESET1, TTR1, TBLDUMP1, GTABLEBUILD1,
  MODEERROR1, MPUCINUMTEST1, PTTR1, RTTR1, NTTR1,
  POLLTTR1, PTABLEDUMP1, RTABLEDUMP1, NTABLEDUMP1, GTABLEDUMP1,
POLLTABLEDUMP1, RTABLEBUILD1, PTABLEBUILD1, POLLTABLEDUMP2,
   NTABLEBUILD1, POLLDUMPBUILD1, GPOLLBUILD1, CHECKIN$DELETE,
```

```
  RPOLLBUILD1, RPOLLBUILD1, OVERFLOW1, OVERFLOW2) LABEL;
DECLARE POLLTABLE1(1473) BYTE;
DECLARE (POLLPOINTER1, PT1COUNT1) ADDRESS INITIAL (0,0);
            POLLPOINTER1 = 0;
            PT1COUNT1 = 0;
DECLARE PTLHEADER DATA
   ('PRIORITY CHECKIN TABLE DUMP',0DH,0AH);
DECLARE RTLHEADER DATA
   ('ROUTINE CHECKIN TABLE DUMP',0DH,0AH);
DECLARE NTLHEADER DATA
   ('NO TRAFFIC CHECKIN TABLE DUMP',0DH,0AH);
DECLARE GTLHEADER DATA
    ('GROUP CHECKIN TABLE DUMP', 0DH, 0AH );
DECLARE ADRERRORHDR DATA
    ('** INCORRECT ADR CHARACTERS **');
DECLARE ERRORHDR DATA
   ('** INCORRECT MODE CHARACTER **');
DECLARE TFRERRORHDR DATA
   ('TABLE TRANSFER ERROR: NO CHECKINS');
DECLARE OVERFLOWHDR DATA
   ('** CHECKINS AT THE LIMIT **');
DECLARE POLLDUMPHDR DATA
    ('POLL TABLE DUMP: CHANNEL A', 0DH,0AH ) ;
DECLARE POLLMSGOVER DATA
    ('** ALL POLL MESSAGES LOADED **');
/**/
/**/
/**/
/**/
/*   INITIALIZATION MSG TO TERMINAL OPERATOR     */
DECLARE STARTUP$MSG DATA
  ('IMPROVED POLLING SOFTWARE - VERSION 3: 10 JAN. 1980   ');
INITIAL$MSG: WAITING = WAITING + 1;
        DO I = 1 TO 54;
           OUTTABLE(TC + I) = STARTUP$MSG(I -1);
        END;
        TC = TC + 54;
        MSGCOUNT(WAITING) = 54;
/**/
/**/
/**/
/**/
/**/
/**/
/**/
/**/
/**/
/**/
/*          SLOT CALCULATION ALGORITHM          */
IPOLL1: SLOT = INPUT(228);
        SLOT = SLOT XOR 0FFH;
        SLOTL = SLOT AND 0F0H;
        SLOTL = SHR(SLOTL,4);
        SLOTH = SLOT AND 0FH;
        SLOT$COUNT = SLOTH * 10  + SLOTL;
        IF SLOT$COUNT <> 0 THEN TDM$FLAG = '1';
           ELSE TDM$FLAG = '0';
        GO TO POLL$XMIT;
/* SLOT IS INPUTTED AS 2 BCD VALUES ON A SINGLE INPUT */
/*    THE 2 BCD VALUES ARE MASKED OUT INTO SLOTH AND SLOTL  */
/**/
/**/
/*          POLLING ALGORITHM                              */
```

```
/**/
/**/
POLL$XMIT: IF POLL$FLAG <> 01H THEN GO TO IPOLL11;
           IF PT1COUNT1 < 4 THEN GO TO POLL$MODE$ERROR;
              ELSE GO TO POLL$OVER$TEST;
POLL$MODE$ERROR: POLL$FLAG = 0;
                 GO TO MODEERROR1;
POLL$OVER$TEST: IF POLL$MSG$COUNT >= TOTAL$NUM$CI
                   THEN GO TO REPOLL$TEST;
                 ELSE GO TO OUTTABLE1$STATUS$TEST;
REPOLL$TEST: IF AUTO$REPOLL$FLAG = 01H
                THEN GO TO AUTO$POLL$RESTART;
             POLL$FLAG = 0H;
                GO TO POLL$MSG$COMPLETE;
POLL$MSG$COMPLETE: WAITING = WAITING + 1;
           DO I = 1 TO 30;
             OUTTABLE(TC +I) = POLLMSGOVER(I-1);
           END;
           TC = TC + 30;
           MSGCOUNT(WAITING) = 30;
           POLL$MSG$COUNT = 0;
           GO TO IPOLL11;
OUTTABLE1$STATUS$TEST: IF TC1 > 0 THEN GO TO IPOLL11;
                          ELSE GO TO POLLING$MODE$TEST;
POLLING$MODE$TEST: IF TDM$FLAG = '1' THEN GO TO TDM$POLL;
                      ELSE GO TO NON$TDM$POLL;
AUTO$POLL$RESTART: POLL$MSG$COUNT = 0;
                   TDM$POLL$TX$SLOT = TDM$POLL$TX$SLOT$INITIAL;
                     GO TO POLL$MSG$COMPLETE;
NON$TDM$POLL: IF NTDM$POLL$INTERRUPT$FLAG = 01H
                THEN GO TO IPOLL11;
           IF RETRANSMIT$FLAG <> 01H THEN
                POLL$MSG$COUNT = POLL$MSG$COUNT + 1;
             ELSE RETRANSMIT$FLAG = 0;
/*          NON-TDM POLL MSG COMPOSITION                  */
       WAITING1 = WAITING1 + 1;
       OUTTABLE1(TC1 + 1) = 01H;
       OUTTABLE1(TC1 + 2) = '0';
       DO I1 = 1 TO 3;
         OUTTABLE1(TC1 + 2 + I1) =
              POLLTABLE1(I1 + POLL$MSG$COUNT * 4 - 4);
       END;
       OUTTABLE1(TC1 + 6) = 03H;
       OUTTABLE1(TC1 + 7) = 03H;
/**/
/*     ELAC TABLE LOAD        */
   DO J = 1 TO 7;
     NTDM$ELAC$TABLE(J) = OUTTABLE1(TC1 + J);
   END;
/**/
       TC1 = TC1 + 7;
       MSGCOUNT1(WAITING1) = 7;
       GO TO IPOLL11;
TDM$POLL: IF TDM$POLL$INTERRUPT$FLAG = 01H
             THEN GO TO IPOLL11;
         IF SLOT$COUNT = TDM$POLL$TX$SLOT THEN
             TDM$POLL$TX$SLOT = TDM$POLL$TX$SLOT + 1;
          ELSE GO TO IPOLL11;
    IF TDM$POLL$TX$SLOT >= TDM$POLL$TX$SLOT$INITIAL + 8 THEN
             TDM$POLL$TX$SLOT = TDM$POLL$TX$SLOT$INITIAL;
/*     TDM POLL MSG COMPOSITION                 */
    IF TOTAL$NUM$CI - POLL$MSG$COUNT >= 6 THEN N = 6;
       ELSE N = TOTAL$NUM$CI - POLL$MSG$COUNT;
```

```
    WAITING1 = WAITING1 + 1;
    DO J = 1 TO N;
       POLL$MSG$COUNT = POLL$MSG$COUNT + 1;
       OUTTABLE1(TC1 +1) = 01H;
       OUTTABLE1(TC1 +2) = '0';
       DO I1 = 1 TO 3;
          OUTTABLE1(TC1 + 2 + I1) =
            POLLTABLE1(I1 + POLL$MSG$COUNT * 4  - 4);
       END;
       TC1 = TC1 + 6;
       OUTTABLE1(TC1) = 03H;
    END;
    MSGCOUNT1(WAITING1) = N * 6;
/**/
/**/
/*       INPUT FROM MODEM        */
/**/
/**/
IPOLL1: CS = CS$DATA XOR 0FFH;
CS3 = CS AND 04H;
IF CS3 <> 04H THEN GO TO XX;
CHAR = INPUT3$DATA;
GO TO WW;
XX: CS = CS AND 01H;
IF CS=01H THEN GO TO GC;
WW: IF CC > 0 THEN GO TO LCT;
   ELSE GO TO OPOLL1;
/*  MODEM INPUT   */
GC: CHAR = INPUT3$DATA XOR 0FFH;
CC= CC+1;
IF CC >= 2000 THEN GO TO LCT;
CHAR$STORE(CC) = CHAR;
IF CC=1 THEN GO TO ST;
   ELSE GO TO MJT1;
/*        ENCRYPTION TEST         */
ENCTEST: IF CHAR = 0AAH THEN GO TO ENCRYPT;
ELSE GO TO LCT;
/*            SOH TEST              */
ST: IF CHAR = SOH THEN GO TO LCT;
    IF CHAR = '*' THEN GO TO LCT;
IF CHAR = 0AAH THEN GO TO ENCRYPT;
   ELSE MJF=1;
GO TO LCT;
ENCRYPT: ENC = ENC + 1;
GO TO LCT;
/*     MPU JOB TEST     */
MJT1: IF MJF=1 THEN GO TO LCT;
IF CC = 2 THEN GO TO ENCTEST;
IF ENC = 2 THEN OUTPUT(233) = 11H;
IF CC=3 THEN GO TO CHAR3T;
IF CC=4 THEN GO TO CHAR4T;
IF CC=5 THEN GO TO CHAR5T;
   ELSE GO TO LCT;
CHAR3T: IF CHAR = ADR1 THEN GO TO LCT;
   ELSE MJF=1;
GO TO LCT;
CHAR4T: IF CHAR= ADR2 THEN GO TO LCT;
   ELSE MJF=1;
GO TO LCT;
CHAR5T: IF CHAR= ADR3 THEN GO TO LCT;
   ELSE MJF=1;
/*  LAST CHARACTER TEST */
LCT: TCLK = INPUT(230);
```

```
      TCLK = TCLK AND 01H;
      IF TCLK = TCLKP THEN GO TO OPOLL1;
      TCLKCNT = TCLKCNT + 1;
      TCLKP = TCLK;
      IF TCLKCNT < 24H THEN GO TO OPOLL1;
      TCLK = 0;
      TCLKP = 0;
      TCLKCNT = 0;
CC$PRESENT = CC$PRESENT + 1;
IF CC$PRESENT > CC THEN CC$PRESENT = 0;
      ELSE GO TO OPOLL1;
   OUTPUT(233) = 10H;
   ENC = 0;
/**/
/**/
/**/
/*    EDAC ALGORITHM - NON TDM POLLING MSG'S    */
EDAC$ROUTINE: IF EDAC$FLAG <> 01H THEN GO TO MJT2;
      IF MJF <> 1 THEN GO TO MJT2;
      IF POLL$FLAG <> 01H THEN GO TO MJT2;
      IF TDM$FLAG <> '0' THEN GO TO MJT2;
      IF CC <> 7 THEN GO TO MJT2;
      DO J = 1 TO 7;
        IF CHAR$STORE(J) <> NTDM$EDAC$TABLE(J)
           THEN GO TO RETRANSMIT$FLAG$SET;
      END;
      RETRANSMIT$FLAG = 0H;
      REPOLL$FLAG$COUNT = 0;
      GO TO MJT2;
RETRANSMIT$FLAG$SET: RETRANSMIT$FLAG = 01H;
      REPOLL$FLAG$COUNT = REPOLL$FLAG$COUNT + 1;
      IF REPOLL$FLAG$COUNT > 3 THEN REPOLL$FLAG$COUNT = 0;
      IF REPOLL$FLAG$COUNT = 0 THEN RETRANSMIT$FLAG = 0H;
/**/
  /* MODE TEST & FORMATTING */
MJT2: IF MJF=1 THEN GO TO MPU$TABLE$BUILD ;
MODE= CHAR$STORE(2);
IF MODE = 'C' THEN GO TO CS$TEST;
IF MODE = 'L' THEN GO TO CS$TEST;
IF MODE = 'E' THEN GO TO CS$TEST;
IF MODE = 'F' THEN GO TO PRB$LOAD;
IF MODE = 'N' THEN GO TO NRB$LOAD;
IF MODE = 'R' THEN GO TO RRB$LOAD;
IF MODE = 'X'THEN GO TO PTT$LOAD;
IF MODE = 'Y' THEN GO TO RTT$LOAD;
IF MODE = 'Z' THEN GO TO NTT$LOAD;
GO TO MPU$TABLE$BUILD;
/**/
/**/
/*  CHECKIN STATUS TEST  */
CS$TEST: IF C$MODE= '1' THEN GO TO CC$TEST;
STAR$INSERT: CHAR$STORE(1) = '?' ;
GO TO OUT$TABLE$BUILD;
/*  CHARACTER COUNT TEST  */
/*  THE CC TEST REQUIRES PCI/RCI/NCI CHECKINS TO HAVE  */
/*      A MINIMUM OF 9 CHARACTERS. MESSAGES, HOWEVER, MAY */
/*      BE APPENDED AFTER THE 9TH CHARACTER.            */
CC$TEST: IF CC >= 9 THEN GO TO PCI$TEST;
   ELSE CHAR$STORE(1) = '?' ;
GO TO OUT$TABLE$BUILD;
PCI$TEST: IF MODE <> 'C' THEN GO TO RCI$TEST;
   ELSE NUM$PCI = NUM$PCI + 1;
PCI$POINTER = 4 * ( NUM$PCI - 1 ) + 1 ;
```

```
DO I = 6 TO 9 ;
   PCI$STORE(PCI$POINTER) = CHAR$STORE(I) ;
   PCI$POINTER = PCI$POINTER + 1 ;
END ;
DO I = 0 TO 12 ;
   OUT$TABLE(TC + I + 1) = PCI$HEADER(I) ;
END;
NC = CC + 13;
TC = TC + 13;
GO TO CI$NUM$TEST;
NCI$TEST: IF MODE <> 'D' THEN GO TO NCI$TEST;
   ELSE NUM$RCI = NUM$RCI + 1;
RCI$POINTER = 4 * ( NUM$RCI - 1 ) + 1 ;
DO I = 6 TO 9 ;
   RCI$STORE(RCI$POINTER) = CHAR$STORE(I) ;
   RCI$POINTER = RCI$POINTER + 1;
END;
DO I = 0 TO 3 ;
   OUT$TABLE(TC + I + 1) = RCI$HEADER(I) ;
END;
NC = CC + 4;
TC = TC + 4;
GO TO CI$NUM$TEST;
NCI$TEST: NUM$NCI = NUM$NCI + 1;
NCI$POINTER = 4 * ( NUM$NCI - 1 ) + 1 ;
DO I = 6 TO 9 ;
   NCI$STORE(NCI$POINTER) = CHAR$STORE(I);
   NCI$POINTER = NCI$POINTER + 1 ;
END;
DO I = 0 TO 3 ;
  OUT$TABLE(TC + I +1) = NCI$HEADER(I) ;
END;
NC = CC + 4;
TC = TC + 4;
/**/
/**/
CI$NUM$TEST: IF NUM$PCI + NUM$RCI + NUM$NCI >= 60
                    THEN GO TO CI$MODE$CANCEL;
        ELSE GO TO OUT$TABLE$BUILD;
/*  ALL-CALL CHECKIN MODE CANCEL          */
C$MODE$CANCEL: IF POLL$FLAG = C1H THEN GO TO C$MODE$CANCEL1;
               DO I1 = 1 TO 27;
          OUTTABLE1(TC1+I1) = OVERFLOWHDR(I1-1);
               END;
     TC1 = TC1 + 27;
     WAITING1 = WAITING1 + 1;
       MSGCOUNT1(WAITING1) = 27,
/*     CHECKIN MODE CANCEL MSG TO TERMINAL OPERATOR    */
C$MODE$CANCEL1: DO I = 1 TO 27;
          OUT$TABLE(TC+I) = OVERFLOWHDR(I-1);
       END;
       TC = TC + 27;
       NC = NC + 27;
       CIMODE = '0';
       GO TO OUT$TABLE$BUILD ;
/**/
/**/
NPU$TABLE$BUILD: NC = CC ;
OUT$TABLE$BUILD: DO I = 1 TO CC;
   OUT$TABLE(TC + I) = CHAR$STORE(I);
END;
TC = TC + CC ;
WAITING = WAITING + 1;
```

```
MSG$COUNT(WAITING) = NC;
CC = 0 ;
NC = 0;
MJF = 0;
OUTPUT(233) = 10H;
ENC = 0;
GO TO OPCL11;
/**/
/**/
PRB$LOAD: DO I = 0 TO 11 ;
   OUT$TABLE(TC + I + 1) = PRB$HEADER(I) ;
END;
NC = CC + 12 ;
TC = TC + 12 ;
GO TO OUT$TABLE$BUILD;
RRB$LOAD: DO I = 0 TO 3 ;
   OUT$TABLE(TC + I + 1) = RRB$HEADER(I) ;
END;
NC = CC + 4;
TC = TC + 4;
GO TO OUT$TABLE$BUILD;
NRB$LOAD: DO I = 0 TO 3 ;
   OUT$TABLE(TC + I + 1) = NRB$HEADER(I) ;
END;
NC = CC + 4 ;
TC = TC + 4 ;
GO TO OUT$TABLE$BUILD;
/**/
/**/
PTT$LOAD: IF C$MODE = '0' THEN GO TO STAR$INSERT;
   IF CC < 9 THEN GO TO STAR$INSERT;
   DO I = 6 TO CC BY 4;
      NUM$PCI = NUM$PCI + 1;
      PCI$POINTER = 4 * (NUM$PCI - 1) + 1;
      DO J = 0 TO 3;
        PCI$STORE( PCI$POINTER ) = CHAR$STORE(I+J);
        PCI$POINTER = PCI$POINTER + 1;
      END;
   IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO PTT$LOAD$END;
   IF (CC - I) < 4 THEN GO TO PTT$LOAD$END;
  END;
PTT$LOAD$END: DO I = 0 TO 11;
   OUT$TABLE(TC + I + 1) = PTT$HEADER(I) ;
END;
NC = CC + 12 ;
TC = TC + 12 ;
IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO C$MODE$CANCEL;
GO TO OUT$TABLE$BUILD;
RTT$LOAD: IF C$MODE = '0' THEN GO TO STAR$INSERT;
   IF CC < 9 THEN GO TO STAR$INSERT;
   DO I = 6 TO CC BY 4;
      NUM$RCI = NUM$RCI + 1;
      RCI$POINTER = 4 * (NUM$RCI - 1) + 1;
      DO J = 0 TO 3;
        RCI$STORE( RCI$POINTER ) = CHAR$STORE(I + J);
        RCI$POINTER = RCI$POINTER + 1;
      END;
   IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO RTT$LOAD$END;
   IF (CC - I) < 4 THEN GO TO RTT$LOAD$END;
  END;
RTT$LOAD$END: DO I = 0 TO 3;
   OUT$TABLE(TC + I + 1) = RTT$HEADER(I) ;
END;
```

```
NC = CC + 4 ;
TC = TC + 4 ;
IF NUM$PCI + NUM$RCI + NUM$NCI >= 60 THEN GO TO C$MODE$CANCEL;
GO TO OUT$TABLE$BUILD;
NTT$LOAD: IF C$MODE = '0' THEN GO TO STAR$INSERT;
   IF CC < 5 THEN GO TO STAR$INSERT;
   DO I = 6 TO CC BY 4;
        NUM$NCI = NUM$NCI + 1;
        NCI$POINTER = 4 * (NUM$NCI - 1) + 1;
      DO J = 0 TO 3;
         NCI$STORE( NCI$POINTER ) = CHAR$STORE(I+J);
         NCI$POINTER = NCI$POINTER + 1;
      END;
   IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO NTT$LOAD$END;
   IF (CC -I) < 4 THEN GO TO NTT$LOAD$END;
  END;
NTT$LOAD$END: DO I = 0 TO 3;
   OUT$TABLE(TC + I + 1) = NTT$HEADER(I) ;
END;
NC = CC + 4;
TC = TC + 4 ;
IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO C$MODE$CANCEL;
GO TO OUT$TABLE$BUILD;
  /*  MPU OUTPUT  */
OPOLL1: IF DELAY = 1 THEN GO TO DELAY$ROUTINE;
         IF WAITING <= 0 THEN GO TO IPOLL101;
         IF TC > 0 THEN GO TO EOM$TEST;
            ELSE GO TO IPOLL101;
EOM$TEST: IF OUT$COUNT < MSG$COUNT(1) THEN GO TO SPACE$TEST ;
    ELSE DELAY = 1;
SPACE$TEST: IF RS232$FLAG = 01H THEN GO TO RS232$SPACE$TEST;
SPACE = INPUT5$DATA XOR 0FFH;
SPACE = SPACE AND 02H;
IF SPACE = 02H THEN GO TO OUT$CHAR ;
   ELSE DELAY = 0;
GO TO IPOLL101;
/**/
RS232$SPACE$TEST: SPACE = INPUT(237);
                  SPACE = SPACE AND 01H;
                  IF SPACE = 01H THEN GO TO OUT$CHAR;
                     ELSE DELAY = 0;
                  GO TO IPOLL101;
/**/
DELAY$ROUTINE: CLK = INPUT(230);
               CLK = CLK AND 01H;
     IF CLK = CLKP THEN GO TO IPOLL101;
     CLKCNT = CLKCNT + 1;
     CLKP = CLK;
     IF CLKCNT < BUFFER$DELAY THEN GO TO IPOLL101;
     OUTPUT(235) = 0H;
     IF CLKCNT < MSG$DELAY THEN GO TO IPOLL101;
     DELAY = 0;
     CLKCNT = 0;
     GO TO IPOLL101;
/**/
/*  OUTPUT TO MPU   */
/**/
OUTCHAR: IF RS232$FLAG = 01H THEN GO TO RS232$OUTCHAR;
 OUTPUT(235) = 01H;
 OUTPUT1$DATA = OUT$TABLE(OUT$COUNT) XOR 0FFH;
OUT$COUNT = OUT$COUNT + 1 ;
GO TO SHIFTDOWN;
/**/
```

```
RS232$OUTCHAR: OUTPUT(237) = 25H;
               OUTPUT(236) = OUTSTABLE(OUT$COUNT);
               OUT$COUNT = OUT$COUNT + 1;
SHIFTDOWN: IF OUT$COUNT <= MSG$COUNT(1) THEN GO TO IPOLL101;
        OUTPUT(237) = 15H;
        DO I = OUT$COUNT TO TC ;
         OUTSTABLE( I + 1 - OUT$COUNT ) = OUTSTABLE( I ) ;
        END;
DO I = 1 TO WAITING ;
   MSG$COUNT(I) = MSG$COUNT(I+1) ;
END;
TC = TC - ( OUT$COUNT -1 ) ;
MSGCOUNT(WAITING) = 0;
WAITING = WAITING - 1 ;
OUT$COUNT = 1 ;
IF WAITING = 0 THEN TC = 0;
   /*  TX & RX MAJOR LOOP - MPU  */
/**/
/**/
/**/
IPOLL101: IF RS232$FLAG = 01H THEN GO TO RS232$INPUT1;
             ELSE GO TO IPOLL1011;
/**/
RS232$INPUT1: CS1 = INPUT(237);
              CS1 = CS1 AND 02H;
              IF CS1 = 02H THEN CHAR1 = INPUT(236);
                 ELSE GO TO IPOLL1011;
              GO TO RS232$GC1;
/**/
IPOLL1011: CS1 = CS1$DATA XOR 0FFH;
CS4 = CS1 AND 04H;
IF CS4 <> 04H THEN GO TO YY;
CHAR1 = INPUT103$DATA;
GO TO ZZ;
YY: CS1 = CS1 AND 01H;
IF CS1 = 01H THEN GO TO GC1;
ZZ: IF CC1 > 0 THEN GO TO LCT1;
  ELSE GO TO OPOLL101;
/**/
/*      INPUT FROM MPU       */
/**/
GC1: CHAR1 = INPUT103$DATA XOR 0FFH;
RS232$GC1: CC1 = CC1 + 1;
  IF CC1 >= 2000 THEN GO TO LCT1;
CHARSTORE1(CC1) = CHAR1;
/* */
/*  HEADER TEST */
/*  */
IF CC1 <= 3 THEN GO TO LCT1;
IF CC1 = 4 THEN GO TO CHAR4T1;
IF CC1 >= 5 THEN GO TO LCT1;
CHAR4T1: IF CHAR1 = 21H THEN OUT1 = 0;
           ELSE GO TO OUTFLAG1;
        GO TO LCT1;
OUTFLAG1:    OUT1 = 1;
/**/
/*     LAST CHARACTER TEST     */
/**/
LCT1: TCLK1 = INPUT(230);
      TCLK1 = TCLK1 AND 01H;
      IF TCLK1 = TCLKP1 THEN GO TO OPOLL101;
      TCLKCNT1 = TCLKCNT1 + 1;
      TCLKP1 = TCLK1;
```

```
        IF TCLKCNT1 < MSG$OVER$DELAY THEN GO TO OPOLL101;
        TCLK1 = 0;
        TCLKE1 = 0;
        TCLKCNT1 = 0;
        CC1$PRESENT = CC1$PRESENT + 1;
        IF CC1$PRESENT > CC1 THEN CC1$PRESENT = 0;
        ELSE GO TO OPOLL101;
/**/
/**/
/*  */
/*  */
/*  OUTPUT COMPOSITION */
/*  */
/*  */
OUTPUT$COMPOSE: IF OUT1 <> 1 THEN GO TO COMPOSE1;
  DO CASE EAT$MSG$FLAG1;
     GO TO MODEM$OUTPUT$COMPOSE1;
     IF POLL$FLAG = 01H THEN GO TO EAT$MSG1;
            ELSE GO TO MODEM$OUTPUT$COMPOSE1;
     GO TO EAT$MSG1;
  END;
MODEM$OUTPUT$COMPOSE1: IF CHARSTORE1(4) = '*' THEN
                           GO TO MODEM$OUTPUT$COMPOSE2;
  DO I1 = 1 TO CC1;
OUTTABLE1(TC1 + I1) = CHARSTORE1(I1);
END;
TC1 = TC1 + CC1;
WAITING1 = WAITING1 +1;
MSGCOUNT1(WAITING1) = CC1;
EAT$MSG1: CC1 = 0;
OUT1 = 0;
GO TO OPOLL101;
/**/
/*  LOOP-AROUND OUTPUT MESSAGE COMPOSITION    */
/**/
MODEM$OUTPUT$COMPOSE2: DO I1 = 4 TO CC1;
                  OUTTABLE1(TC1 + I1 - 3) = CHARSTORE1(I1);
                         END;
           TC1 = TC1 + CC1 ;
           WAITING1 = WAITING1 + 1;
           MSGCOUNT1(WAITING1) = CC1 ;
           CC1 = 0;
           OUT1 = 0;
           GO TO OPOLL101;
/**/
/*  COMPOSITION PROGRAM */
/* */
/* TEST MODE CHARACTER */
/* */
COMPOSE1: IF CC1 < 8 THEN GO TO MODEERROR1;
IF CHARSTORE1(6) <> ADR1 THEN GO TO ADRERROR1;
IF CHARSTORE1(7) <> ADR2 THEN GO TO ADRERROR1;
IF CHARSTORE1(8) <> ADR3 THEN GO TO ADRERROR1;
/**/
/*  COMSUP MODE RECOGNITION CHARACTERS   */
/**/
IF CHARSTORE1(5) = 'A' THEN GO TO GCIRESET;
IF CHARSTORE1(5) = 'B' THEN GO TO GT1;
IF CHARSTORE1(5) = 'C' THEN GO TO FT1;
  IF CHARSTORE1(5) = 'D' THEN GO TO RT1;
  IF CHARSTORE1(5) = 'E' THEN GO TO NT1;
  IF CHARSTORE1(5) = 'F' THEN GO TO PCIRESET;
  IF CHARSTORE1(5) = 'G' THEN GO TO NCIRESET;
```

```
  IF CHARSTORE1(5) = 'H' THEN GO TO NCIRESET;
  IF CHARSTORE1(5) = 'I' THEN GO TO ADRCHANGE;
  IF CHARSTORE1(5) = 'J' THEN GO TO POLL$MODE;
  IF CHARSTORE1(5) = 'K' THEN GO TO NON$TDM$DELAY$SET;
  IF CHARSTORE1(5) = 'L' THEN GO TO POLL$INTERRUPT;
  IF CHARSTORE1(5) = 'M' THEN GO TO POLLTABLEBUILD1;
  IF CHARSTORE1(5) = 'N' THEN GO TO CHECKIN$DELETE;
  IF CHARSTORE1(5) = 'O' THEN GO TO SLOT$REASSIGN;
  IF CHARSTORE1(5) = 'P' THEN GO TO EDAC$MODE$SET;
   IF CHARSTORE1(5) = 'Q' THEN GO TO RS232$MODE$SET;
IPL$TEST: IF CHARSTORE1(5) = 'R' THEN GO TO PROGRAM$START;
  IF CHARSTORE1(5) = 'S' THEN GO TO CHECKINMODESET1;
  IF CHARSTORE1(5) = 'T' THEN GO TO TTR1;
  IF CHARSTORE1(5) = 'U' THEN GO TO TBLDUMP1;
  IF CHARSTORE1(5) = 'V' THEN GO TO EAT$MSG$SET;
IF CHARSTORE1(5) = 'X' THEN GO TO PTTR1;
IF CHARSTORE1(5) = 'Y' THEN GO TO RTTR1;
IF CHARSTORE1(5) = 'Z' THEN GO TO NTTR1;
IF CHARSTORE1(5) = '1' THEN GO TO PTT$LOAD1;
IF CHARSTORE1(5) = '2' THEN GO TO RTT$LOAD1;
IF CHARSTORE1(5) = '3' THEN GO TO NTT$LOAD1;
  ELSE GO TO MODEERROR1;
/**/
/**/
SLOT$REASSIGN: IF CC1 < 22 THEN GO TO MODEERROR1;
   IF CHARSTORE1(21) > 35H THEN GO TO MODEERROR1;
   IF CHARSTORE1(21) < 30H THEN GO TO MODEERROR1;
   IF CHARSTORE1(22) > 39H THEN GO TO MODEERROR1;
   IF CHARSTORE1(22) < 30H THEN GO TO MODEERROR1;
   TX$SLOT$INITIALH = (CHARSTORE1(21) - 30H) * 10;
   TX$SLOT$INITIALL =  CHARSTORE1(22) - 30H ;
   IF TX$SLOT$INITIALH + TX$SLOT$INITIALL > 54 THEN GO TO MODEERROR1;
   IF TX$SLOT$INITIALH + TX$SLOT$INITIALL = 0 THEN GO TO MODEERROR1;
   TDM$POLL$TX$SLOT$INITIAL = TX$SLOT$INITIALH + TX$SLOT$INITIALL;
   TDM$POLL$TX$SLOT = TDM$POLL$TX$SLOT$INITIAL;
/*  TDM$POLL$TX$SLOT$INITIAL IS LIMITED TO A RANGE OF 1 TO 54  */
      POLL$SLOT1H = CHARSTORE1(9);
      POLL$SLOT1L = CHARSTORE1(10);
      POLL$SLOT2H = CHARSTORE1(11);
      POLL$SLOT2L = CHARSTORE1(12);
      POLL$SLOT3H = CHARSTORE1(13);
      POLL$SLOT3L = CHARSTORE1(14);
      POLL$SLOT4H = CHARSTORE1(15);
      POLL$SLOT4L = CHARSTORE1(16);
      POLL$SLOT5H = CHARSTORE1(17);
      POLL$SLOT5L = CHARSTORE1(18);
      POLL$SLOT6H = CHARSTORE1(19);
      POLL$SLOT6L = CHARSTORE1(20);
      GO TO COMSUPLOAD1;
/**/
RS232$MODE$SET: IF CC1 < 9 THEN GO TO MODEERROR1;
         IF CHARSTORE1(9) = '0' THEN RS232$FLAG = 0H;
         IF CHARSTORE1(9) = '1' THEN RS232$FLAG = 01H;
         GO TO COMSUPLOAD1;
/**/
/**/
EAT$MSG$SET: IF CC1 < 9 THEN GO TO MODEERROR1;
         IF CHARSTORE1(9) = '0' THEN EAT$MSG$FLAG1 = 0H;
         IF CHARSTORE1(9) = '1' THEN EAT$MSG$FLAG1 = 01H;
         IF CHARSTORE1(9) = '2' THEN EAT$MSG$FLAG1 = 02H;
         CHARSTORE1(9) = EAT$MSG$FLAG1 + 30H;
         GO TO COMSUPLOAD1;
/**/
```

```
/**/
EDAC$MODE$SET: IF CC1 < 9 THEN GO TO ADRERROR1;
       IF CHARSTORE1(9) = '1' THEN EDAC$FLAG = 01H;
       IF CHARSTORE1(9) = '0' THEN EDAC$FLAG = 0H;
       GO TO COMSUPLOAD1;
/**/
/**/
ADRCHANGE: IF CC1 < 11 THEN GO TO ADRERROR1;
           ADR1 = CHARSTORE1(9);
           ADR2 = CHARSTORE1(10);
           ADR3 = CHARSTORE1(11);
           GO TO COMSUPLOAD1;
/**/
/**/
POLL$MODE: IF CC1 < 10 THEN GO TO ADRERROR1;
           IF CHARSTORE1(9) = '0' THEN POLL$FLAG = 0H;
           IF CHARSTORE1(9) = '1' THEN POLL$FLAG = 01H;
/*   INITIALIZATION OF POLLING MODE          */
     IF CHARSTORE1(9) = '1' THEN POLL$MSG$COUNT = 0;
     IF CHARSTORE1(9) = '1' THEN
           TDM$POLL$TX$SLOT = TDM$POLL$TX$SLOT$INITIAL;
     IF CHARSTORE1(9) = '1' THEN REPOLL$FLAG$COUNT = 0;
     IF CHARSTORE1(9) = '1' THEN RETRANSMIT$FLAG = 0H;
           IF CHARSTORE1(10) = 'S' THEN AUTO$REPOLL$FLAG = 0H;
           IF CHARSTORE1(10) = 'M' THEN AUTO$REPOLL$FLAG = 01H;
           GO TO COMSUPLOAD1;
/**/
/**/
POLL$INTERRUPT: IF CC1 < 10 THEN GO TO ADRERROR1;
                IF CHARSTORE1(9) = '1' THEN
      NTDM$POLL$INTERRUPT$FLAG = 01H;
                IF CHARSTORE1(9) = '0' THEN
      NTDM$POLL$INTERRUPT$FLAG = 0H;
                IF CHARSTORE1(10) = '1' THEN
      TDM$POLL$INTERRUPT$FLAG = 01H;
                IF CHARSTORE1(10) = '0' THEN
      TDM$POLL$INTERRUPT$FLAG = 0H;
      CHARSTORE1(9) = NTDM$POLL$INTERRUPT$FLAG + 30H;
      CHARSTORE1(10) = TDM$POLL$INTERRUPT$FLAG + 30H;
      GO TO COMSUPLOAD1;
/**/
/**/
NON$TDM$DELAY$SET: IF CC1 < 10 THEN GO TO ADRERROR1;
      IF CHARSTORE1(9) < 30H THEN GO TO MODEERROR1;
      IF CHARSTORE1(9) > 39H THEN GO TO MODEERROR1;
      IF CHARSTORE1(10) < 30H THEN GO TO MODEERROR1;
      IF CHARSTORE1(10) > 39H THEN GO TO MODEERROR1;
  /* CHARACTERS 9 & 10 ARE DELAY ENTERED IN SECONDS    */
  /*         MAXIMUM DELAY IS 99 SECONDS               */
      NTDMDELAYH = CHARSTORE1(9) - 30H;
      NTDMDELAYL = CHARSTORE1(10) - 30H;
DELAY$CAL: NON$TDM$MSG$DELAY1 = (NTDMDELAYH*300H) + (NTDMDELAYL*30H);
      GO TO COMSUPLOAD1;
/**/
/**/
/*  ADR ERROR MESSAGE   */
ADRERROR1: DO I = 1 TO 30;
             OUTTABLE(TC + I) = ADRERRORHDR(I-1);
           END;
           WAITING = WAITING + 1;
           TC = TC + 30;
           OUTTABLE(TC +1) = 0DH;
           OUTTABLE(TC +2) = 0AH;
```

```
            OUTTABLE(TC+ 3) = ADR1;
            OUTTABLE(TC +4) = ADR2;
            OUTTABLE(TC +5) = ADR3;
            OUTTABLE(TC +6) = 03H;
            OUTTABLE(TC +7) = 03H;
            TC = TC + 7;
            MSGCOUNT(WAITING) = 37;
            GO TO CONSUPLOAD1;
/**/
/*  */
/* ADDITIONS TO CI TABLES */
/**/
/*    CHECKIN TABLE TRANSFERS FROM FPU BY CONSUP COMMAND    */
/**/
PTT$LOAD1: IF CC1 < 12 THEN GO TO MODEERROR1;
      IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO OVERFLOW1;
      DO I = 9 TO CC1 BY 4;
         NUM$PCI = NUM$PCI + 1;
         PCI$POINTER = 4 * (NUM$PCI - 1) + 1;
         DO J = 0 TO 3;
            PCI$STORE(PCI$POINTER ) =
                 CHARSTORE1(I +J);
            PCI$POINTER = PCI$POINTER + 1;
         END;
         IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO TT$LOAD$END1;
         IF (CC1 - I) < 4 THEN GO TO TT$LOAD$END1;
       END;
       GO TO CONSUPLOAD1;
RTT$LOAD1: IF CC1 < 12 THEN GO TO MODEERROR1;
      IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO OVERFLOW1;
      DO I = 9 TO CC1 BY 4;
         NUM$RCI = NUM$RCI + 1;
         RCI$POINTER = 4 * (NUM$RCI - 1) + 1;
         DO J = 0 TO 3;
            RCI$STORE(RCI$POINTER ) =
                 CHARSTORE1(I +J);
            RCI$POINTER = RCI$POINTER + 1;
         END;
         IF NUM$PCI + NUM$RCI + NUM$NCI >= 60 THEN GO TO TT$LOAD$END1;
         IF (CC1 - I) < 4 THEN GO TO TT$LOAD$END1;
       END;
       GO TO CONSUPLOAD1;
NTT$LOAD1: IF CC1 < 12 THEN GO TO MODEERROR1;
      IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO OVERFLOW1;
      DO I = 9 TO CC1 BY 4;
         NUM$NCI = NUM$NCI + 1;
         NCI$POINTER = 4 * (NUM$NCI - 1) + 1;
         DO J = 0 TO 3;
            NCI$STORE(NCI$POINTER ) =
                 CHARSTORE1(I +J);
            NCI$POINTER = NCI$POINTER + 1;
         END;
         IF NUM$PCI + NUM$RCI + NUM$NCI >= 60 THEN GO TO TT$LOAD$END1;
         IF (CC1 -I) < 4 THEN GO TO TT$LOAD$END1;
       END;
       GO TO CONSUPLOAD1;
TT$LOAD$END1: IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO
                 TO OVERFLOW1;
                    ELSE GO TO CONSUPLOAD1;
/* */
/* */
/*  PRIORITY  */
/* */
```

```
/* */
PT1:  IF NUM$PCI + NUM$RCI + NUM$NCI >=  80 THEN GO TO
      OVERFLOW1;
NUM$PCI = NUM$PCI + 1;
PCI$POINTER = 4 * ( NUM$PCI - 1 ) + 1;
DO I = 9 TO 12;
PCI$STORE(PCI$POINTER) = CHARSTORE1(I);
PCI$POINTER = PCI$POINTER + 1;
END;
GO TO COMSUPLOAD1;
/* */
/* */
/*  ROUTINE */
/* */
/* */
RT1:  IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO
        OVERFLOW1;
NUM$RCI = NUM$RCI + 1;
RCI$POINTER = 4 * ( NUM$RCI - 1 ) + 1;
DO I = 9 TO 12;
  RCI$STORE(RCI$POINTER) = CHARSTORE1(I);
  RCI$POINTER = RCI$POINTER + 1;
END;
GO TO COMSUPLOAD1;
/* */
/* */
/*  NO TRAFFIC */
/* */
/* */
NT1:  IF NUM$PCI + NUM$RCI + NUM$NCI >= 80 THEN GO TO
        OVERFLOW1;
NUM$NCI = NUM$NCI + 1;
NCI$POINTER = 4 * ( NUM$NCI - 1 ) + 1;
DO I = 9 TO 12;
  NCI$STORE(NCI$POINTER) = CHARSTORE1(I);
  NCI$POINTER = NCI$POINTER + 1;
END;
GO TO COMSUPLOAD1;
/**/
/**/
/*      GROUP CHECKIN        */
/**/
GT1: IF CC1 < 11 THEN GO TO ADRERRCK1;
IF NUM$GCI >= 64 THEN GO TO OVERFLOW2;
N = 0;
DO I = 1 TO 16;
      NUM$GCI = NUM$GCI + 1;
      GCI$POINTER = 4*(NUM$GCI -1)+1;
      GCI$STORE(GCI$POINTER) = CHARSTORE1(9);
      GCI$STORE(GCI$POINTER + 1) = CHARSTORE1(10);
      DO CASE N;
         GCI$STORE(GCI$POINTER + 2) = '0';
         GCI$STORE(GCI$POINTER + 2) = '1';
         GCI$STORE(GCI$POINTER + 2) = '2';
         GCI$STORE(GCI$POINTER + 2) = '3';
         GCI$STORE(GCI$POINTER + 2) = '4';
         GCI$STORE(GCI$POINTER + 2) = '5';
         GCI$STORE(GCI$POINTER + 2) = '6';
         GCI$STORE(GCI$POINTER + 2) = '7';
         GCI$STORE(GCI$POINTER + 2) = '8';
         GCI$STORE(GCI$POINTER + 2) = '9';
         GCI$STORE(GCI$POINTER + 2) = 'A';
         GCI$STORE(GCI$POINTER + 2) = 'B';
```

```
            GCI$STORE(GCI$POINTER + 2) = 'C';
            GCI$STORE(GCI$POINTER + 2) = 'D';
            GCI$STORE(GCI$POINTER + 2) = 'E';
            GCI$STORE(GCI$POINTER + 2) = 'F';
         END;
          N = N + 1;
          GCI$STORE(GCI$POINTER + 3) = CHARSTORE1(11);
          GCI$POINTER = GCI$POINTER + 5;
          IF NUM$GCI >= 64 THEN GO TO OVERFLOW2;
END;
GO TO CONSUPLOAD1;
/**/
/**/
CHECKINSDELETE: IF CC1 < 11 THEN GO TO ADRERROR1;
                N=4;
         IF CHARSTORE1(9) = 'P' THEN N = 0;
         IF CHARSTORE1(9) = 'R' THEN N = 1;
         IF CHARSTORE1(9) = 'N' THEN N = 2;
         IF CHARSTORE1(9) = 'G' THEN N = 3;
  /*                                                   */
         IF N = 4 THEN GO TO MODEERROR1;
         IF CHARSTORE1(10) - 30H > 6 THEN GO TO MODEERROR1;
         IF CHARSTORE1(11) - 30H > 9 THEN GO TO MODEERROR1;
  /*                                                   */
     J = (CHARSTORE1(10) - 30H) * 10 + (CHARSTORE1(11) - 30H);
  /*                                                   */
         DO CASE N;
           IF J > NUM$PCI THEN GO TO MODEERROR1;
           IF J > NUM$RCI THEN GO TO MODEERROR1;
           IF J > NUM$NCI THEN GO TO MODEERROR1;
           IF J > NUM$GCI THEN GO TO MODEERROR1;
         END;
  /*                                                   */
         DO CASE N;
            IF NUM$PCI = 0 THEN GO TO MODEERROR1;
            IF NUM$RCI = 0 THEN GO TO MODEERROR1;
            IF NUM$NCI = 0 THEN GO TO MODEERROR1;
            IF NUM$GCI = 0 THEN GO TO MODEERROR1;
         END;
  /*                                                  */
         DO CASE N;
            DO I = 4*J+1 TO 4*NUM$PCI;
               PCI$STORE(I-4) = PCI$STORE(I);
            END;
            DO I = 4*J+1 TO 4*NUM$RCI;
               RCI$STORE(I-4) = RCI$STORE(I);
            END;
            DO I = 4*J+1 TO 4*NUM$NCI;
               NCI$STORE(I-4) = NCI$STORE(I);
            END;
            DO I = 4*J+1 TO 4*NUM$GCI;
               GCI$STORE(I-4) = GCI$STORE(I);
            END;
         END;
  /*                                                  */
         DO CASE N;
            NUM$PCI = NUM$PCI - 1;
            NUM$RCI = NUM$RCI - 1;
            NUM$NCI = NUM$NCI - 1;
            NUM$GCI = NUM$GCI - 1;
         END;
  /*                                                  */
         DO CASE N;
```

```
          PCI$POINTER = PCI$POINTER - 4;
          RCI$POINTER = RCI$POINTER - 4;
          NCI$POINTER = NCI$POINTER - 4;
          GCI$POINTER = GCI$POINTER - 4;
        END;
  /*                                              */
        GO TO CONSUPLOAD1;
/**/
/**/
/*   MPU CI NUMBER TEST   */
/**/
/**/
MPUCINUMTEST1: IF NUM$NCI + NUM$PCI + NUM$RCI>= 80
THEN GO TO OVERFLOW1;
  ELSE GO TO CONSUPLOAD1;
/**/
/**/
/*           OVERFLOW MESSAGE           */
/**/
/**/
OVERFLOW1: C$MODE = '0';
OVERFLOW2: DO I = 1 TO 27;
  OUT$TABLE( TC + I ) = OVERFLOWHDR(I - 1 ) ;
END;
WAITING = WAITING + 1;
TC = TC + 27;
OUTTABLE(TC +1) = 03H;
OUTTABLE(TC +2) = 03H;
TC = TC + 2;
MSGCOUNT(WAITING) = 29;
CC1 = 0;
GO TO CPOLL101;
/* */
/* */
/*  CHECKIN MODE SET  */
/* */
/* */
CHECKINMODESET1: IF CC1 < 9 THEN GO TO ADRERROR1;
                   IF CHARSTORE1(9) = '0' THEN C$MODE = '0';
                  IF CHARSTORE1(9) = '1' THEN C$MODE = '1';
                     ELSE C$MODE = 'C';
IF NUM$PCI + NUM$RCI + NUM$NCI >= 60 THEN GO TO OVERFLOW1;
    ELSE GO TO CONSUPLOAD1;
/**/
/**/
/*  RESET OF CHECKIN TABLES   */
/**/
/**/
PCIRESET: NUM$PCI = 0;
          PCI$POINTER = 0;
          GO TO CONSUPLOAD1;
RCIRESET: NUM$RCI = 0;
          RCI$POINTER = 0;
          GO TO CONSUPLOAD1;
NCIRESET: NUM$NCI = 0;
          NCI$POINTER = 0;
          GO TO CONSUPLOAD1;
GCIRESET: NUM$GCI = 0;
          GCI$POINTER = 0;
/**/
/**/
/*          CONSUP MSG RETURN TO TERMINAL OPERATOR   */
/**/
```

```
/**/
COMSUPLOAD1: DO I = 1 TO CC1;
  OUTSTABLE( TC + I ) = CHARSTORE1(I);
END;
TC = TC + CC1;
WAITING = WAITING + 1;
OUTTABLE(TC +1) = 03H;
OUTTABLE(TC +2) = 03H;
TC = TC +2;
MSG$COUNT(WAITING) = CC1 +2;
NOCOMSUPLOAL1: CC1 = 0;
GO TO CPOLL101;
/* */
/*     ERROR MESSAGE DUMP   */
/**/
/**/
MODEERROR1: DO I = 1 TO 30;
   OUTSTABLE( TC + I ) = ERRORHDR(I - 1) ;
END;
TC = TC + 30;
WAITING = WAITING + 1;
MSGCOUNT(WAITING) = 0;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 30;
CC1 = 0;
GO TO CPOLL101;
/**/
/* */
/*  TABLE TRANSFERS  */
/* */
/*  MAKE UP HEADER  */
/* */
TTR1: OUTTABLE1(TC1 + 1) = '*';
OUTTABLE1(TC1 + 2) = CHARSTORE1(9);
TC1INITIAL = TC1;
DO I= 1 TO 3;
  OUTTABLE1( TC1 + 2 + I) = CHARSTORE1( I+9 ) ;
END;
/* */
/*  SELECT TABLE  */
/* */
IF CHARSTORE1(9) = 'X' THEN GO TO PTTR1;
IF CHARSTORE1(9) = 'Y' THEN GO TO RTTR1;
IF CHARSTORE1(9) = 'Z' THEN GO TO NTTR1;
IF CHARSTORE1(9) = 'T' THEN GO TO POLLTTR1;
  ELSE GO TO MODEERROR1;
/* */
/* */
/*  PCI TABLE LOAD  */
/* */
/* */
PTTR1: IF NUM$PCI = 0 THEN GO TO TFERROR1;
WAITING1= WAITING1 + 1;
MSGCOUNT1(WAITING1) = 0;
TC1 = TC1 + 5;
N = 4*NUM$PCI;
  DO I = 1 TO N;
   OUTTABLE1( TC1 + I) = PCI$STORE(I);
  END;
TC1 = TC1 + N;
OUTTABLE1(TC1+1) = 03H;
OUTTABLE1(TC1+2) = 03H;
TC1 = TC1 + 2;
MSGCOUNT1(WAITING1) = TC1 - TC1INITIAL;
```

```
GO TO COMSUPLOAD1;
/* */
/* */
/*  RCI TABLE LOAD  */
/* */
/* */
RTTR1: IF NUMSRCI = 0 THEN GO TO TFERROR1;
WAITING1= WAITING1 + 1;
MSGCOUNT1(WAITING1) = 0;
TC1 = TC1 + 5;
N = 4*NUMSRCI;
  DO I = 1 TO N;
   OUTTABLE1( TC1 + I) = RCISSTORE(I);
  END;
TC1 = TC1 + N;
OUTTABLE1(TC1+1) = 03H;
OUTTABLE1(TC1+2) = 03H;
TC1 = TC1 + 2;
MSGCOUNT1(WAITING1) = TC1 - TC1INITIAL;
GO TO COMSUPLOAD1;
/* */
/* */
/*  NCI TABLE LOAD  */
/* */
/* */
NTTR1: IF NUMSNCI = 0 THEN GO TO TFERROR1;
WAITING1= WAITING1 + 1;
MSGCOUNT1(WAITING1) = 0;
TC1 = TC1 + 5;
N = 4*NUMSNCI;
  DO I = 1 TO N;
   OUTTABLE1( TC1 + I) = NCISSTORE(I);
  END;
TC1 = TC1 + N;
OUTTABLE1(TC1+1) = 03H;
OUTTABLE1(TC1+2) = 03H;
TC1 = TC1 + 2;
MSGCOUNT1(WAITING1) = TC1 - TC1INITIAL;
GO TO COMSUPLOAD1;
/* */
/* */
/*  POLL TABLE LOAD ( ALL CALL )  */
/* */
/* */
POLLTTR1: IF PT1COUNT1 <= 0  THEN GO TO TFERROR1;
WAITING1= WAITING1 + 1;
MSGCOUNT1(WAITING1) = 0;
TC1 = TC1 + 5;
  DO I = 1 TO PT1COUNT1;
   OUTTABLE1(TC1 + I) = POLLTABLE1(I) ;
  END;
TC1 = TC1 + PT1COUNT1;
OUTTABLE1(TC1+1) = 03H;
OUTTABLE1(TC1+2) = 03H;
TC1 = TC1 + 2;
MSGCOUNT1(WAITING1) = TC1 - TC1INITIAL;
GO TO COMSUPLOAD1;
/**/
/**/
/*   TABLE TRANSFER ERROR MESSAGE DUMP   */
/**/
TFERROR1: DO I = 1 TO 33;
            OUTTABLE(TC + I) = TFERRORHDR(I-1);
```

```
            END;
            TC = TC + 33;
            WAITING = WAITING + 1;
            MSGCOUNT(WAITING) = 33;
           CC1 = 0;
            GO TO OPOLL101;
/* */
/* */
/*  TABLE DUMPS  */
/* */
/* */
/*  MAKE UP HEADER  */
/* */
/* */
TBLDUMP1: IF CC1 < 12 THEN GO TO ADRERROR1;
  OUT$TABLE(TC + 1) = 01H;
OUT$TABLE(TC + 2) = '3';
TC = TC + 2;
DO I = 1 TO 3 ;
  OUT$TABLE( TC + I ) = CHARSTORE1( I+9 )  ;
END;
TC = TC + 3;
WAITING = WAITING + 1;
MSGCOUNT(WAITING ) = 5;
/* */
/* */
/*  SELECT TABLE  */
/* */
/* */
IF CHARSTORE1(9) = 'O' THEN GO TO GTABLEDUMP1;
IF CHARSTORE1(9) = 'P' THEN GO TO PTABLEDUMP1;
IF CHARSTORE1(9) = 'R' THEN GO TO RTABLEDUMP1;
IF CHARSTORE1(9) = 'Q' THEN GO TO NTABLEDUMP1;
IF CHARSTORE1(9) = 'Z' THEN GO TO POLLTABLEDUMP1;
  ELSE GO TO MODEERROR1;
/* */
/* */
/* PRIORITY */
/* */
/* */
PTABLEDUMP1: DO I = 1 TO 29;
 OUT$TABLE(TC + I) = PTDHEADER(I - 1);
END;
TC = TC + 29 ;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 29 ;
IF NUM$PCI = 0 THEN GO TO COMSUPLOAD1;
N = 1;
/*  OUTPUTTING OF PCI TABLE- 8 CHECKINS PER LINE  */
PTABLEBUILD1: DO I = 1 TO 8;
        DO J = 1 TO 4;
TC = TC + 1;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1;
           OUT$TABLE(TC) = PCI$STORE(N);
           IF N >= PCI$POINTER THEN GO TO COMSUPLOAD1;
N = N + 1;
        END;
TC = TC + 1 ;
OUT$TABLE (TC ) = 20H;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1 ;
END;
TC = TC + 1 ;
OUT$TABLE (TC ) = 0DH;
TC = TC + 1;
```

```
OUT$TABLE (TC ) = 0AH;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 2 ;
GO TO PTABLEBUILD1;
/**/
/**/
/*     RCUTINE      */
/**/
/**/
RTABLEDUMP1: DO I = 1 TO 28;
OUT$TABLE (TC + I) = RTDHEADER(I-1);
END;
TC = TC + 28;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 28;
IF NUM$RCI = 0 THEN GO TO COMSUPLOAD1;
N = 1;
/*  OUTPUTTING OF RCI TABLE- 8 CHECKINS PER LINE  */
RTABLEBUILD1:  DO I = 1 TO 8;
DO J = 1 TO 4;
TC = TC+  1;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) +  1;
OUT$TABLE(TC) = RCI$STORE(N);
IF N >= RCI$POINTER THEN GO TO COMSUPLOAD1;
N = N + 1;
END;
TC = TC +  1;
OUT$TABLE (TC ) = 20H;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1;
END;
TC = TC + 1;
OUT$TABLE (TC )= 0DH;
TC = TC +1;
OUT$TABLE (TC ) = 0AH;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 2;
GO TO RTABLEBUILD1;
/**/
/**/
/*     NC     TRAFFIC     */
/**/
NTABLEDUMP1: DO I = 1 TO 31;
OUT$TABLE (TC + I ) = NTDHEADER(I-1);
END;
TC = TC + 31;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 31;
IF NUM$NCI = 0 THEN GO TO COMSUPLOAD1;
N = 1;
/*  OUTPUTTING OF NCI TABLE - 8 CHECKINS PER LINE  */
NTABLEBUILD1:  DO I = 1 TO 8;
   DO J = 1 TO 4;
TC = TC + 1;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1;
OUT$TABLE (TC ) = NCI$STORE (N);
IF N >= NCI$POINTER THEN GO TO COMSUPLOAD1;
N = N + 1;
END;
TC = TC + 1;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1;
OUT$TABLE (TC) = 20H;
END;
TC = TC + 1;
OUT$TABLE (TC) = 0DH;
TC = TC + 1;
OUT$TABLE (TC) = 0AH;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING)+ 2;
```

```
GO TO NTABLEBUILD1;
/**/
/**/
/*          GROUP CHECKIN          */
/**/
GTABLEDUMP1: DO I = 1 TO 26;
  OUTTABLE(TC + I) = GTDHEADER(I-1);
END;
TC = TC + 26;
MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 26;
IF NUMSGCI = 0 THEN GO TO CONSUPLOAD1;
N=1;
/*  OUTPUTTING OF GCI TABLE - 8 CHECKINS PER LINE  */
GTABLEBUILD1: DO I = 1 TO 8;
                DO J = 1 TO 4;
            TC = TC + 1;
            MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1;
            OUTTABLE(TC) = GCI$STORE(N);
            IF N >= GCI$POINTER THEN GO TO CONSUPLOAD1;
            N = N + 1;
         END;
         TC = TC + 1;
         OUTTABLE(TC) = 20H;
         MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 1;
       END;
       TC = TC + 1;
       OUTTABLE(TC) = 0DH;
       TC = TC + 1;
       OUTTABLE(TC) = 0AH;
       MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + 2;
       GO TO GTABLEBUILD1;
/**/
/**/
/*              P O L L          */
/**/
/**/
POLLTABLEDUMP2: WAITING = WAITING + 1;
                TOTAL$NUM$CI = NUM$ECI + NUM$RCI + NUM$NCI + NUM$GCI;
                PT1COUNT1 = 4 * TOTAL$NUM$CI;
   /*   RESET OF POLLING MODE PARAMETERS          */
        POLL$FLAG = 0;
        REPOLL$FLAG$COUNT = 0;
        POLL$MSG$COUNT = 0;
        TDM$POLL$TX$SLOT = TDM$POLL$TX$SLOT$INITIAL;
POLLTABLEDUMP1: IF TOTAL$NUM$CI = 0 THEN GO TO CONSUPLOAD1;
  IF CHARSTORE1(13) = 'R' THEN POLL$TABLE$TX$FLAG = 01H;
    ELSE POLL$TABLE$TX$FLAG = 0H;
DO I = 1 TO 26;
OUT$TABLE (TC + I ) = POLLDUMPHDR(I-1);
END;
TCINITIAL = TC;
TC = TC + 26;
/* OUTPUTTING OF POLL TABLE- 8 CHECKINS PER LINE */
POLLDUMPBUILD1: LINECOUNT = 0;
N= 0;
/*    SLOT ASSIGNMENT HEADER   -  FIRST LINE      */
/**/
J = 1;
OUTTABLE(TC + 1) = 28H;
OUTTABLE(TC + 2) = POLL$SLOT1H;
OUTTABLE(TC + 3) = POLL$SLOT1L;
OUTTABLE(TC + 4) = 29H;
OUTTABLE(TC + 5) = 20H;
```

```
TC = TC + 5;
LINECOUNT = LINECOUNT + 5;
LOADADR: DO I = 1 TO 4;
            OUTTABLE(TC+I) = POLLTABLE1(N+I);
         END;
N = N+4;
OUTTABLE(TC+5) = 20H;
LINECOUNT = LINECOUNT + 5;
TC = TC + 5;
IF N >= PT1COUNT1 THEN GO TO ENDLOAD;
IF LINECOUNT < 45 THEN GO TO LOADADR;
   ELSE GO TO ENDLOAD;
ENDLOAD: OUTTABLE(TC+1) = 0DH;
         OUTTABLE(TC+2) = 0AH;
         TC = TC + 2;
         LINECOUNT = 0;
         MSGCOUNT(WAITING) = MSGCOUNT(WAITING) + (TC-TCINITIAL);
         TCINITIAL = TC;
IF N >= PT1COUNT1 THEN GO TO POLL$TABLE$TX;
/*   SLOT ASSIGNMENT HEADER   -   ADD'L LINES     */
OUTTABLE(TC + 1) = 28H;
DO CASE J;
   OUTTABLE(TC + 2) = POLL$SLOT1H;
   OUTTABLE(TC + 2) = POLL$SLOT2H;
   OUTTABLE(TC + 2) = POLL$SLOT3H;
   OUTTABLE(TC + 2) = POLL$SLOT4H;
   OUTTABLE(TC + 2) = POLL$SLOT5H;
   OUTTABLE(TC + 2) = POLL$SLOT6H;
END;
DO CASE J;
   OUTTABLE(TC + 3) = POLL$SLOT1L;
   OUTTABLE(TC + 3) = POLL$SLOT2L;
   OUTTABLE(TC + 3) = POLL$SLOT3L;
   OUTTABLE(TC + 3) = POLL$SLOT4L;
   OUTTABLE(TC + 3) = POLL$SLOT5L;
   OUTTABLE(TC + 3) = POLL$SLOT6L;
END;
OUTTABLE(TC + 4) = 29H;
OUTTABLE(TC + 5) = 20H;
TC = TC + 5;
LINECOUNT = LINECOUNT + 5;
J = J + 1;
IF J > 5 THEN J = 0;
GO TO LOADADR;
/**/
/**/
POLL$TABLE$TX: IF POLL$TABLE$TX$FLAG <> 01H
                 THEN GO TO COMSUPLOAD1;
       WAITING1 = WAITING1 + 1;
       DO I1 = 1 TO MSGCOUNT(WAITING);
        OUTTABLE1(TC1+I1) = OUTTABLE(TC+I1-MSGCOUNT(WAITING));
       END;
   /*                                              */
   /*   ALL-CALL HEADER SUBSTITUTION               */
        OUTTABLE1(TC1 + 1) = 'S';
        OUTTABLE1(TC1 + 2) = 'L';
        OUTTABLE1(TC1 + 3) = 'O';
        OUTTABLE1(TC1 + 4) = 'T';
        OUTTABLE1(TC1 + 5) = 2FH;
   /*                                              */
       MSGCOUNT1(WAITING1) = MSGCOUNT(WAITING);
       TC1 = TC1 + MSGCOUNT(WAITING);
       POLL$TABLE$TX$FLAG = 0;
```

```
      GO TO CONSUPLOAD1;
/**/
/**/
/*      POLL TABLE SETUP      */
/**/
/**/
/**/
/*      GET P C I  DATA       */
/**/
/**/
POLLTABLEBUILD1: IF NUM$PCI = 0 THEN GO TO RPOLLBUILD1;
N = 4*NUM$PCI;
DO I = 1 TO N;
  POLLTABLE1(I) = PCI$STORE(I);
END;
/**/
/**/
/*      GET R C I DATA      */
/**/
/**/
RPOLLBUILD1: IF NUM$RCI = 0 THEN GO TO NPOLLBUILD1;
N = 4*NUM$RCI;
POLLPOINTER1 = 4 * NUM$PCI;
DO I = 1 TO N;
  POLLTABLE1(POLLPOINTER1 + I) = RCI$STORE(I);
END;
/**/
/**/
/*  GET N C I DATA      */
/**/
/**/
NPOLLBUILD1: IF NUM$NCI = 0 THEN GO TO GPOLLBUILD1;
N = 4*NUM$NCI;
POLLPOINTER1 = 4 * (NUM$PCI + NUM$RCI);
DO I = 1 TO N;
  POLLTABLE1( POLLPOINTER1 + I ) = NCI$STORE(I);
END;
/**/
/**/
/*       GET GCI DATA      */
/**/
/**/
GPOLLBUILD1: IF NUM$GCI = 0 THEN GO TO POLLTABLEDUMP2;
      N = 4*NUM$GCI;
      POLLPOINTER1 = 4 * (NUM$PCI + NUM$RCI + NUM$NCI);
      DO I = 1 TO N;
        POLLTABLE1(POLLPOINTER1 + I) = GCI$STORE(I);
      END;
      GO TO POLLTABLEDUMP2;
/**/
/**/
/*      OUTPUT     */
/**/
OPOLL101: IF DELAY1 = 1 THEN GO TO DELAY$ROUTINE1;
           IF WAITING1 <= 0 THEN GO TO IPOLL1;
           IF TC1 > 0 THEN GO TO EOMTEST1;
              ELSE GO TO IPOLL1;
EOMTEST1:  IF OUTCOUNT1 < MSGCOUNT1(1) THEN GO TO SPACETEST1;
             ELSE DELAY1 = 1;
SPACETEST1: SPACE1 = INPUT105$DATA XOR OFFH;
SPACE1 = SPACE1 AND 02H;
IF SPACE1 = 02H THEN GO TO OUTCHAR1;
   ELSE DELAY1 = 0;
```

```
 GO TO IPOLL1;
/**/
/**/
/*        DELAY ROUTINES         */
/**/
/**/
DELAY$ROUTINE1: CLK1 = INPUT(230);
      CLK1 = CLK1 AND 01H;
      IF CLK1 = CLKP1 THEN GO TO IPOLL1;
      CLKCNT1 = CLKCNT1 + 1;
      CLKP1 = CLK1;
      IF CLKCNT1 < BUFFER$DELAY1 THEN GO TO IPOLL1;
      OUTPUT(235) = 08H;
      IF TDMSFLAG <> '1' THEN GO TO NONSTDM$DELAY1;
TDM$DELAY$ROUTINE1: CLK3 = INPUT(230);
      CLK3 = CLK3 AND 01H;
      IF CLK3 = CLKP3 THEN GO TO IPOLL1;
      CLKCNT3 = CLKCNT3 + 1;
      CLKP3 = CLK3;
      IF CLKCNT3 < SLOT$GUARD$TIME THEN GO TO IPOLL1;
      DELAY1 = 0;
      CLKCNT1 = 0;
      CLKCNT2 = 0;
      CLKCNT3 = 0;
      GO TO IPOLL1;
NONSTDM$DELAY1: CLK2 = INPUT(230);
                 CLK2 = CLK2 AND 01H;
         IF CLK2 = CLKP2 THEN GO TO IPOLL1;
         CLKCNT2 = CLKCNT2 + 1;
         CLKP2 = CLK2;
         IF CLKCNT2 < NONSTDM$MSG$DELAY1 THEN GO TO IPOLL1;
         IF CC = 0 THEN DELAY1 = 0H;
           ELSE DELAY1 = 01H;
         IF NONSTDM$MSG$DELAY1 <= 30H THEN GO TO RX$BUSY$OVERRIDE1;
         CLKCNT1 = 0;
         CLKCNT2 = 0;
         CLKCNT3 = 0;
         GO TO IPOLL1;
/**/
/**/
RX$BUSY$OVERRIDE1: DELAY1 = 0;
         DO CASE POLL$FLAG;
            NONSTDM$MSG$DELAY1 = 0;
            NONSTDM$MSG$DELAY1 = 30H;
         END;
         CLKCNT1 = 0;
         CLKCNT2 = 0;
         CLKCNT3 = 0;
         GO TO IPOLL1;
/**/
/**/
OUTCHAR1: OUTPUT(235) = 09H;
 OUTPUT1O1$DATA = OUTTABLE1(OUTCOUNT1) XOR OFFH;
OUTCOUNT1 = OUTCOUNT1 + 1;
SHIFTDOWN1: IF OUTCOUNT1 <= MSGCOUNT1(1) THEN GO TO IPOLL1;
ELSE DO I1 = OUTCOUNT1 TO TC1;
OUTTABLE1 ( I1 +1 - OUTCOUNT1) = OUTTABLE1(I1);
END;
DO I1 = 1 TO WAITING1;
MSGCOUNT1(I1) = MSGCOUNT1(I1 + 1 );
END;
TC1 = TC1 - ( OUTCOUNT1 - 1 ) ;
MSGCOUNT1(WAITING1) = 0;
```

```
WAITING1 = WAITING1 - 1 ;
OUTCOUNT1 = 1;
IF WAITING1 = 0 THEN TC1 = 0;
GO TO IPOLL1;
QUIT: OUTPUT(2) = CC;
      OUTPUT(2) = CC1;
      OUTPUT(2) = MSGCOUNT(1);
      OUTPUT(2) = MSGCOUNT1(1);
      OUTPUT(2) = TC;
      OUTPUT(2) = TC1;
      OUTPUT(2) = OUTCOUNT;
      OUTPUT(2) = OUTCOUNT1;
      OUTPUT(2) = WAITING;
      OUTPUT(2) = WAITING1;
      OUTPUT(2) = NUM$PCI;
      OUTPUT(2) = NUM$RCI;
      OUTPUT(2) = NUM$NCI;
      OUTPUT(2) = NUM$GCI;
      OUTPUT(2) = PT1COUNT1;
EOF
```

GLOSSARY

AFSATCOM	Air Force Satellite Communications
AFSC	Air Force Systems Command
ASR	automatic send receive
BCD	binary coded decimal
b/s	bits per second
CINC	Commander-in-Chief
CMOS	complementary metal-oxide semiconductor
COMSUP	communications supervisory
CP	command post
CPU	central processing unit
CRT	cathode ray tube
EAM	emergency action message
EDAC	error detection and correction
EPROM	eraseable programmable read-only memory
ESD	Electronic Systems Division
FLTSATCOM	Fleet Satellite Communications
FSA	free storage area
FSK	frequency shift keying
IC	integrated circuit
I/O	input/output
ISA	instruction storage area
LSI	large scale integration

GLOSSARY (Continued)

MI	message indicator
MPU	message processor unit
NB	narrowband
NCA	National Command Authority
NCS	net control station
OW	orderwire
PROM	programmable read-only memory
R/T	receiver/transmitter
RX	receive
SBC	single board computer
SDS	Satellite Data System
SIOP	Single Integrated Operations Plan
SSDA	synchronous serial data adapter
TDM	time division multiplex
TTL	transistor-transistor logic
TX	transmit
UHF	ultra high frequency
VSA	variable storage area
WB	wideband
WWABNCP	Worldwide Airborne Command Post

DAT

ILM